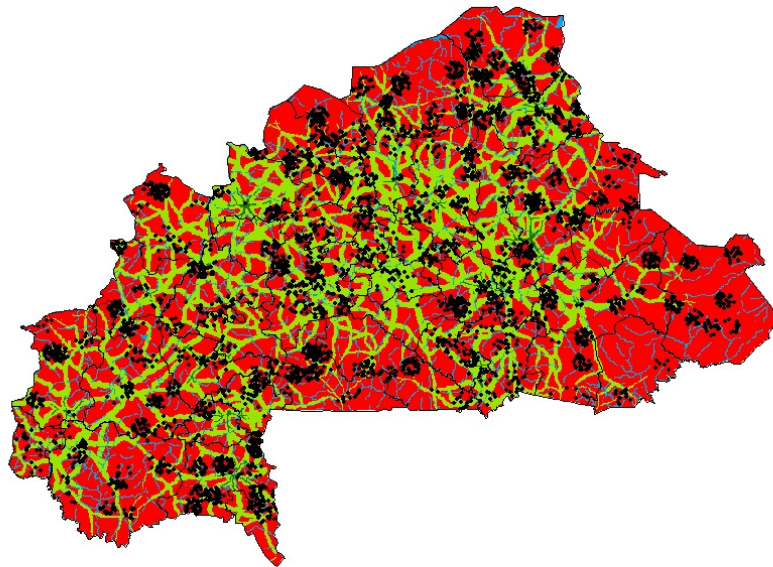# World Health Organization

Investing the Marginal Dollar for Maternal and Newborn Health: Geographic Accessibility Analysis for Emergency Obstetric Care services in Burkina Faso

Steeve Ebener, PhD [1] **and Karin Stenberg, MSc** [2]

[1] *Consultant, Gaia GeoSystems, The Philippines*

[2] *Technical Officer, Department of Health Systems Governance and Financing, World Health Organization, Geneva, Switzerland*

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Acknowledgements

Executive summary

Objective

Progress on MDG5a to reduce maternal mortality is lagging behind in many countries and a key constraint is access to skilled care at birth including emergency obstetric care (EmOC) services. In order to expand coverage, good-quality essential services must be integrated into strong health systems.

The World Health Report 2005 proposed a "close to client" approach with back up services at referral level. While the first level should be able to provide most of the Basic Emergency Obstetric Care (BEmOC) signal functions, there is also a universal need for access to comprehensive Emergency Obstetric Care (CEmOC) referral services, in case the need arises.

In recognition of the key impact that EmOC services can have on maternal mortality and safe birth outcomes, the World Health Organization (WHO) is supporting the use of Geographic Information Systems (GIS) to analyse physical accessibility to facilities providing EmOC in five selected countries, namely (by alphabetical order): Burkina Faso, Cambodia, Lao People's Democratic Republic, and Malawi.[1]

Essentially, from a normative perspective every woman should be able to easily access a health facility that provides BEmOC. This is not currently the case in most low-income countries. Strategic decisions need to be made by policy makers and health planners with regards to what investments are feasible given limited resources and competing priorities.

The broader project aims to inform policy discussions on how to optimize or target the spending of the marginal dollar for maternal health at country level; in particular to examine the infrastructure requirements for scaling up coverage of institutional delivery with skilled attendance. The research undertaken as part of this project and presented here aims to investigate the current accessibility to EmOC and potential implications for future global and national level policy recommendations and norms.

Methodology

The analysis first assesses accessibility coverage[2]. It then combines the results with data on the availability of human resources in the facilities providing the concerned health services, in order to obtain a measure combining both the population needs and service availability. This measure is referred to as geographic coverage.

In the case of Burkina Faso, working in close collaboration with the Ministry of Health through the WHO Country Office, a freely available GIS extension developed by WHO to measure physical accessibility to health care, called AccessMod (See Chapter 4), has

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[2] Refers to ensuring that health services are located within reasonable reach of the people who should benefit from it (Tanahashi, 1978)

been used in combination with statistical data from existing sources (including household surveys, Health Information System, etc..) to perform the following analyses for the country (See Chapter 5 for more details):

1. Accessibility coverage:
   a. The percentage of all births where the household is located within 2 hours of travel time to a BEmOC facility;
   b. The travel time between each BEmOC facility and the nearest CEmOC facility.
2. Geographic coverage:
   a. The percentage of all births where the household is located within 2 hours of travel time to a BEmOC facility with enough capacity to cover all births under the assumption of normal delivery (i.e., with sufficient availability of skilled birth attendants);
   b. The percentage of births with complications requiring blood transfusion/Caesarean-section (C-section) that will reach a CEmOC facility within 2 hours of travel time from BEmOC facilities, and where the CEmOC facility has enough capacity to manage complications (through the availability of EmOC surgical teams).
3.   Service utilization: Comparison between the results from the accessibility/geographic coverage analysis with data on actual service utilization (BEmOC coverage compared with the percentage of births delivered in a health facility; sub national level estimated percentage and health facility level number of births referred to CEmOC facilities for complication compared with the corresponding percentage and number of caesarean-sections observed during a recent year).
4.   Scaling up: Scenarios developed to reach universal coverage through various mechanisms of expanding the EmOC facility network.

The results coming out of these analyzes (Chapter 7) are presented under the form of tables, graphs and maps to be included into the analysis of maternal and new born health investments in the country.

Results

The analyses performed indicate that:
1. From an **accessibility coverage** perspective (Section 7.1, Table 1), the EmOC delivery network identified during the 2010 needs assessment [17] allows for less than two thirds (61%) of all births to reach a BEmOC facility in less than 2 hours. On the positive side there is a CEmOC facility within 2 hours of travel time from each existing BEmOC facility;
2. With regards to CEmOC facilities, the health system in Burkina Faso complies with the condition set to define universal accessibility coverage as per the current framework but this remain conditional on the presence of a functioning motor vehicle being available on site of each BEmOC facility at the moment of the referral;

3. The availability of a motor vehicle at each BEmOC facility should nevertheless be ensured to confirm that the referral system is functioning as assumed.
4. From a **geographic coverage** perspective (Section 7.2, Table 1), when taking into account current capacity and human resources to deliver the required health services, the coverage offered by the existing network of BEmOC facilities is very low, 7.1% at the national level with a considerable variation at the sub national level. The health system therefore does not comply with the definition set for universal geographic coverage (Table 1);
5. For CEmOC facilities, discrepancies among the different sources of health facility level data regarding the number of available EmOC surgical teams meant that the analysis could not assess whether the capacity in each facility would be sufficient to cover the demand would 5% of all births taking place in BEmOC facilities be referred to CEmOC facilities;
6. From a **service utilization** perspective (Section 7.3), when considering the combined walking/carried and motor vehicle traveling scenario and assuming that transportation is made available to pregnant women, the analysis demonstrates that an important number of women are delivering in non-certified EMOC facilities and that and that the most important barriers to BEmOC service utilization differ depending on where pregnant women are living: in 10% of cases, accessibility is the main barrier; in another 76% of cases, it is the availability of services and for the remaining 14% neither accessibility nor availability appear to be the reasons for the non-utilization of EmOC services.

Two types of scenarios were considered for the **scale-up analysis** for BEmOC (Section 7.4).

The first type of scenario considers upgrading partially functional EmOC facilities identified during the 2010 EmONC needs assessment [17] to comply with BEmOC. The second scenario look at establishing waiting homes near each BEmOC facility.

The analysis indicates that upgrading all partially functional EmOC facilities in the country would not significantly increase geographic coverage due to the estimated large spread of the population in rural areas. Alternative strategies such as the establishment of waiting homes near already existing EmOC facilities is likely to have a more significant impact on geographic coverage. Our simulation predicts that such a strategy would enable the targets for accessibility and geographic coverage to be reached for both BEmOC and CEmOC.

A significant additional number of skilled births attendants and EmoC surgical teams would nevertheless have to be recruited and trained in order to reach universal geographic coverage. Indirectly, such an expansion of the workforce would also have an impact in terms of additional working space and equipment in the facilities in question.

Province code [14]	Province name [14]	Accessibility coverage*	Geographic coverage**
BFA046001	Bale	61.4%	2.0%
BFA046002	Banwa	60.8%	7.4%
BFA046003	Kossi	44.2%	0.0%
BFA046004	Mouhoun	61.4%	9.4%
BFA046005	Nayala	58.3%	1.8%
BFA046006	Sourou	76.3%	8.5%
BFA047001	Comoe	58.4%	8.5%
BFA047002	Leraba	51.3%	0.0%
BFA013000	Kadiogo	96.9%	20.5%
BFA048001	Boulgou	59.7%	1.7%
BFA048002	Koulpelogo	45.4%	0.0%
BFA048003	Kouritenga	74.5%	16.5%
BFA049001	Bam	80.8%	8.1%
BFA049002	Namentenga	63.7%	1.5%
BFA049003	Sanmatenga	72.4%	5.1%
BFA050001	Boulkiemde	75.7%	8.4%
BFA050002	Sanguie	67.7%	0.0%
BFA050003	Sissili	40.2%	0.0%
BFA050004	Ziro	47.8%	0.0%
BFA051001	Bazega	47.9%	0.0%
BFA051002	Nahouri	61.4%	0.0%
BFA051003	Zoundweogo	64.4%	1.3%
BFA052001	Gnagna	53.7%	7.2%
BFA052002	Gourma	58.8%	8.3%
BFA052003	Komonjdjari	25.9%	0.0%
BFA052004	Kompienga	22.0%	0.0%
BFA052005	Tapoa	3.1%	0.0%
BFA053001	Houet	68.4%	24.3%
BFA053002	Kenedougou	48.5%	6.1%
BFA053003	Tuy	54.0%	13.3%
BFA054001	Loroum	29.7%	0.0%
BFA054002	Passore	63.3%	0.0%
BFA054003	Yatenga	58.1%	0.0%
BFA054004	Zondoma	56.1%	0.0%
BFA055001	Ganzourgou	62.9%	7.6%
BFA055002	Kourweogo	66.7%	0.0%
BFA055003	Oubritenga	64.2%	0.0%
BFA056001	Oudalan	31.9%	0.0%
BFA056002	Seno	63.9%	9.7%
BFA056003	Soum	41.2%	0.0%
BFA056004	Yagha	17.5%	0.0%
BFA057001	Bougouriba	72.1%	18.4%
BFA057002	Ioba	63.6%	2.0%
BFA057003	Noumbiel	55.3%	0.0%
BFA057004	Poni	60.0%	11.0%

	Nationwide	61.0%	7.1%

*Percentage of births located within 2 hours of travel to a BEmOC (including CEmOC) with the combined walking + vehicle scenario

**Percentage of births located within 2 hours of travel time to a BEmOC (including CEmOC) and for which there is enough capacity in the facilities with the combined walking+vehicle scenario

Table 1 – Province level results for the accessibility and geographic coverage analyzes

Key findings

Despite data limitations[3], the results obtained based on the assumptions made in the context of this project (Chapter 3) provide evidence that should be taken into account for any strategic analysis of maternal health investments in the country.

First of all, the accessibility analysis (Section 7.1) demonstrates that any program aiming to support the transportation of pregnant women at the moment of delivery would have an important positive impact on their chance to reach an BEmOC facility within 2 hours.

The geographic coverage analysis (Section 7.2) illustrates the potential gap that exists in terms of skilled birth attendants in BEmOC facilities in order to cover the demand of the population located within 2 hours of travel time of these facilities.

The service utilization analysis (Section 7.3) confirms that the main barrier, availability or accessibility, depends on where pregnant women are living.

Finally, the scaling-up analysis demonstrates that the second scenario (establishing waiting homes near BEmOC facilities) could be an effective approach but would nevertheless requires transferring and/or recruiting a high number of new skilled births attendants and EmOC surgical teams in these facilities.

While this strategy needs to be further explored it is clear that an increase in the number of skilled birth attendants and EmOC surgical teams in CEmOC facilities is necessary to improve overall availability and accessibility to EmOC in Burkina Faso.

Beyond this, the results obtained provide some basis for a potential revision of some of the indicators considered by the UN [2] when it comes to improving and monitoring the coverage of EmOC facilities and skilled birth attendance in countries. Looking at the National and Province level density of BEmOC and CEmOC facilities in Burkina Faso (Table 2) we can observe that:
-   25 facilities for a total population of 16,968,000 [10] corresponds to a national ratio of 0.74 BEmOC facilities per 500,000 inhabitants. This is far below the benchmark level set in the 2009 handbook [2] when it comes to the availability of EMOC facilities (indicator 1 in Annex 2). The analysis conducted here shows that the current network of BEmOC facilities is indeed insufficient to reach universal accessibility and geographic coverage as per the definition used in the context of the present project (see Chapter 3);
-   The same observation can be made at the Regional and Provincial levels as none of the sub-divisions reach the benchmark level set in the 2009 handbook. With regards to fully functional CEmOC facilities, 44 facilities correspond to a national ratio of 1.4 CEmOC facilities for 500,000 population which is above the benchmark level set in the 2009 handbook [2];

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[3] Data limitations mainly refer to time discrepancies between datasets, some gaps in health facility level datasets and the fact that the needs assessment has been conducted back in 2010 (see Chapter 6).

- The analysis indicates that the current network of CEmOC facilities is sufficient, and well located to be reached in less than 2 hours travel time from BEmOC facilities, and this even in the Regions that are presenting a CEmOC density below the UN benchmark, therefore complying to universal accessibility coverage as defined in the context of this project.

In conclusion, the analysis indicates that benchmarks that consider the density of EmOC facilities at the national or sub national level without taking accessibility and geographic coverage into account may not be appropriate.

The present project could also serve as the basis for justifying further work when it comes to the estimation of the maximum acceptable workload for skilled birth attendants as well as EmOC surgical teams.

Conclusion
The results obtained in the context of this project can be used to inform policy discussions on how to optimize, or target, the spending of the marginal dollar for maternal health in Burkina Faso.

At the same time, benefits could be gained by the health sector if the methods used here are transferred to national institutions and the process as a way to improve the integration of geography and GIS in the Health Information System.

This being said, the needs assessment used in the present study has been conducted back in 2010. The situation depicted here might therefore have changed since then and this both in terms of the EmOC infrastructures and associated human capacities.

As such, the recommendation is for WHO and the Ministry of Health to continue their collaboration in this area and to benefit further from the work that has been performed so far, by continuing the application of the methodology and using the results to strengthen planning for effective programme delivery to improve maternal health and other service delivery areas.

As governments increasingly look at EmOC as a necessary vehicle to reduce maternal mortality, GIS can play an important role. A first step is to undertake an assessment of EmOC capacity at sub-national level, as described in this report. The second step will require interpretation of the results in the national policy context. A subsequent and third step entails the assessment of various strategies to improve maternity care including EmOC components. This may include expanding geographic access, improving system performance by improving the quality of care within current facilities, or addressing barriers on the demand side. The results presented in this report indicate that the strategies required may differ between provinces.

Region Name [14]	Province name [14]	Number of BEmOC facilities (including CEmOC facilities)		Number of CEmOC facilities		Population 2011 (Pop census 2006 [13] adjusted to Pop UN 2011 [10])		Density of BEmOC facilities (including CEmOC facilities) per 500'000 population		Density of CEmOC facilities per 500'000 population	
		Region	Province	Region	Province	Region	Province	Region	Province	Region	Province
Boucle du Mouhoun	Bale	3	0	3	0	1746458	258,350	0.9	0.0	0.9	0.0
	Banwa		1		1		326,080		1.5		1.5
	Kossi		0		0		337,182		0.0		0.0
	Mouhoun		1		1		359,944		1.4		1.4
	Nayala		0		0		197,837		0.0		0.0
	Sourou		1		1		267,065		1.9		1.9
Cascades	Comoe	1	1	1	1	643,758	493,316	0.8	1.0	0.8	1.0
	Leraba		0		0		150,442		0.0		0.0
Centre	Kadiogo	5	5	4	4	2,091,018	2,091,018	1.2	1.2	1.0	1.0
Centre-Est	Boulgou	2	1	0	0	1370314	657,996	0.7	0.8	0.0	0.0
	Koulpelogo		0		0		313,118		0.0		0.0
	Kouritenga		1		0		399,200		1.3		0.0
Centre-Nord	Bam	2	1	2	1	1,455,060	333,121	0.7	1.5	0.7	1.5
	Namentenga		0		0		398,039		0.0		0.0
	Sanmatenga		1		1		723,900		0.7		0.7
Centre-Ouest	Boulkiemde	1	1	1	1	1,436,347	611,556	0.3	0.8	0.3	0.8
	Sanguie		0		0		359,564		0.0		0.0
	Sissili		0		0		252,281		0.0		0.0
	Ziro		0		0		212,946		0.0		0.0
Centre-Sud	Bazega	0	0	0	0	776,472	288,615	0.0	0.0	0.0	0.0
	Nahouri		0		0		190,136		0.0		0.0
	Zoundweogo		0		0		297,721		0.0		0.0
Est	Gnagna	2	1	1	0	1,467,479	494,697	0.7	1.0	0.3	0.0
	Gourma		1		1		370,338		1.4		1.4
	Komonjdjari		0		0		96,244		0.0		0.0
	Kompienga		0		0		91,838		0.0		0.0
	Tapoa		0		0		414,363		0.0		0.0
Hauts-Bassins	Houet	5	3	5	3	1,778,967	1,156,581	1.4	1.3	1.4	1.3
	Kenedougou		1		1		345,836		1.4		1.4
	Tuy		1		1		276,550		1.8		1.8
Nord	Loroum	0	0	0	0	1,435,415	172,925	0.0	0.0	0.0	0.0
	Passore		0		0		391,263		0.0		0.0
	Yatenga		0		0		669,609		0.0		0.0
	Zondoma		0		0		201,618		0.0		0.0
Plateau Central	Ganzourgou	1	1	1	1	842,963	386,612	0.6	1.3	0.6	1.3
	Kourweogo		0		0		167,313		0.0		0.0
	Oubritenga		0		0		289,039		0.0		0.0
Sahel	Oudalan	1	0	1	0	1,172,306	237,216	0.4	0.0	0.4	0.0
	Seno		1		1		320,774		1.6		1.6
	Soum		0		0		420,452		0.0		0.0
	Yagha		0		0		193,865		0.0		0.0
Sud-Ouest	Bougouriba	2	1	2	1	751,443	122,841	1.3	4.1	1.3	4.1
	Ioba		0		0		232,806		0.0		0.0
	Noumbiel		0		0		84,779		0.0		0.0
	Poni		1		1		311,017		1.6		1.6
Nationwide		25		21		16,968,000		0.7		0.6	

Table 2 – National and Province level density of BEmOC, including CEmOC, facilities and CEmOC facilities in Burkina Faso

1. Introduction

Progress on MDG5 to reduce maternal mortality is lagging behind in many countries and a key constraint is access to skilled care at birth including Emergency Obstetric and Newborn Care services.

The World Health Report 2005 proposed a "close to client" approach with back up services at referral level. While the first level should be able to provide most of the Basic Emergency Obstetric Care (BEmOC) signal functions, there is also a universal need for access to comprehensive Emergency Obstetric Care (CEmOC) referral services, in case the need arises.

Essentially, from a normative perspective every facility offering delivery at birth services should be able to provide BEmOC. This is not currently the case in most low-income countries. Strategic decisions need to be made by policy makers and health planners with regards to what investments are feasible given limited resources and competing priorities.

In this regard, component 2c of the International Health Partnership (IHP+) Health System Strengthening (HSS) 2010-2011 proposal to the Norwegian Government on Activities Associated with operationalizing the UN Secretary General's Global Strategy for women and children's health included the present project with the aim to use the capacities of Geographic Information System (GIS) to analyse physical accessibility to Emergency Obstetric Care (EmOC) in four selected countries, namely (by alphabetical order): Burkina Faso, Cambodia, Laos, and Malawi.

This work has been undertaken to inform policy discussions on how to optimize or target the spending of the marginal dollar for maternal health at country level; in particular to examine the infrastructure which is assumed to be available when the marginal dollar is invested in components essential for maternal health (i.e., midwives, birthing kits), and to assess the supply side infrastructure that needs to be in place and considered in conjunction with complementary incentives for demand generation (e.g., conditional cash transfers).

Once the situation analysis and identification of infrastructure constraints has been undertaken, additional analysis is carried out to examine the availability of human resources and capacity to deliver EmOC services within existing facilities. Following identification of strategies within a national policy discussion workshop, a cost analysis can subsequently be carried out to estimate the marginal investment needed to expand coverage of services.

The present report first describes the analytical method, tool and data which have been used to conduct this analysis in Burkina Faso before presenting the results which have been obtained through its implementation. The research findings highlight potential

implications for future global and national level policy recommendations and norms regarding indicators for EmOC accessibility.

Burkina Faso is a landlocked country with a population of approximately 17 million[4]. Ranking 183 out of 186 countries in Human Development Index[5], it is one of the least developed and poorest countries in the world. The majority of the population (77%) live in rural areas[6] and the economy depends primarily on agriculture and animal breeding. Adult literacy rate is low. Only 23% of women and 38% of men know how to read and write[6]. An estimated 43% of the population live under the poverty line[4], making the financial barrier an important factor obstructing women to seek qualified care.

Poor access to care is an important contributing factor to the country's high maternal and neonatal mortality ratios, which are among the highest in the world[6]. Although there has been improvements the last decade in the maternal mortality ratio (484 to 341 per 100 000 live births)[6,7], and the neonatal mortality ratio (43.2 to 28 per 1000 live births) the reduction has not been substantial enough to meet the millennium development goals (MDG). To improve access to care, the government has removed the financial barrier to emergency obstetric care and subsidizes 80% since 2006[8]. Further antenatal care has also been made free of charge as well as the cost for associated supplementation, medicines and materials. Despite this subsidy and the fact that the proportion of births at a health facility with a skilled birth attendant have increased over the past 10 years, there is still a large proportion giving birth at home without a skilled birth attendant (34%)[6], and an even larger proportion in certain rural settings such as the Sahel(65%)[6].

To achieve MDGs 4 and 5, emergency obstetric care (EmOC) has been shown to be one of the most cost-effective strategies in reducing maternal and neonatal deaths[9]. Progress in achieving MDG 4 and 5 has been slow, but by increasing availability, accessibility and quality of obstetric care the MDGs can be achieved. In Burkina Faso the coverage of EmOC facilities is 0.8 per 500,000 inhabitants (to compare with the recommendation of at least 5 BEmOC services per 500,000 inhabitants)[10, 11]. The scarce availability of

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[4] Ministère de l'Economie et des Finances CNdR, Bureau Central du Recensement. Recensement General de la population et de l'habitation (RGPH) de 2006 au Burkina Faso. Burkina Faso; 2008.

[5] UNDP. Rapport sur le développement humain 2013: Programme des Nations Unies pour le développement; 2013.

[6] Institut National de la Statistique et de la Démographie (INSD) Ministère de l'Économie et des Finances, Burkina Faso et ICF International, Calverton, Maryland, USA Enquête Démographique et de santé; 2010.

[7] Institut National de la Statistique et de la Démographie (INSD) Ministère de l'Économie et des Finances, Burkina Faso et ICF International, Calverton, Maryland, USA Enquete Demographique et de santé; 1998.

[8] Stratégie nationale de la subvention des accouchements et des soins obstétricaux et néonataux d'urgence au Burkina Faso. Ministère de la santé 2006.

[9] Freedman LP, Graham WJ, Brazier E, et al. Practical lessons from global safe motherhood initiatives: time for a new focus on implementation. Lancet. Oct 13 2007;370(9595):1383-1391.

[10] *Evaluation des Besoins en Soins Obstétricaux et Néonataux d'Urgence, couplée à la cartographie de l'offre de soins en Santé de la Reproduction au Burkina Faso*: Ministére de la Santé et Institute de recherche en sciences de la santé (IRSS);2011.

CEmOC services is further reflected in the low cesarean section rates 1.9%[12] which is to be compared with the recommendation by WHO of a cesarean section rate by of 5-15% to meet the expected obstetrical complication rate[11]. Although the cesarean section rates during the period 2004 and 2012 and have more than doubled from 0.9% to 1.9%[12,13], there is still an imperative need to further scale up the CEmOC services. Burkina Faso is making progress but it is unlikely that the MDG 4 and 5 will be met by 2015. It is therefore urgent to increase health facility access, especially in the rural areas of the country.

2. Reference indicators and targets

Over time the UN has defined a set of indicators, and associated minimum acceptable levels (targets), to improve and monitor Emergency Obstetric Care coverage and skilled birth attendance in countries, namely:
- The indicators included in the 1997 UNICEF, WHO and UNFPA Guidelines for Monitoring the Availability and Use of Obstetric Services [1] (Annex 1);
- The revision of these indicators as part of the 2009 handbook for monitoring emergency obstetric care [2] (Annex 2);
- MDG indicator 5.2: the proportion of births attended by skilled health personnel trained in providing life saving obstetric care [3].
- The program of Action of the International Conference on Population and Development (ICPD) and more particularly paragraph 64 of the resolution adopted by a special session of the UN General Assembly in 1999 regarding the key actions for the further implementation of the programme of action of the ICPD. This paragraph states that: "All countries should continue their efforts so that globally, by 2005, 80 per cent of all births should be assisted by skilled attendants, by 2010, 85 per cent, and by 2015, 90 per cent." [4].

These indicators have been used as the basis for the assumptions and EmOC referral model used in the context of this project. In particular, the ICPD target that 90% of births should be assisted by a skilled attendant was used to set a benchmark for universal coverage. In the context of our analysis, we further interpreted this target to require that skilled attendance at birth should be available for 90% of births. Skilled attendance at birth is interpreted as a skilled attendant working within an enabling environment or health system that is capable of providing care for normal deliveries as well as appropriate emergency obstetric care for all women who develop complications during childbirth.[14] The assumptions and methodology are presented in the next section.

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[11] WHO. *Monitoring Emergency Obstetric Care - A handbook*2009.

[12] *Annuaire statistique 2012*: Direction Générale de l'Information et des Statistiques Sanitaires (DGISS) du Ministère de la Santé du Burkina Faso; 2013.

[13] *Annuaire statistique 2004*: Direction Générale de l'Information et des Statistiques Sanitaires (DGISS) du Ministère de la Santé du Burkina Faso; 2005.

[14] http://web.unfpa.org/mothers/terms.htm

3. Assumptions related to the EmOC referral system

The following assumptions are considered in the context of the present project:
- Skilled care at birth refers to "the care provided to a woman and her newborn during pregnancy, childbirth and immediately after birth by an accredited and competent health care provider who has at her/his disposal the necessary equipment and the support of a functioning health system, including transport and referral facilities for emergency obstetric care"[15]. This implies having at direct disposal the capacity and capability to the Basic Emergency Obstetric Care lifesaving interventions;
- A BEmOC facility is a health facility that is performing all the 7 Basic EmOC functions, namely [2]: administer parental antibiotics, administer uterotonic drugs (i.e. parental oxytocin), administer parental anticonvulsants for pre-eclampsia and eclampsia (i.e. magnesium sulphate), manually remove the placenta, remove retained products (e.g. manual vacuum extraction, dilation and curettage), perform assisted vaginal delivery (e.g. vacuum extraction, forceps delivery), perform basic neonatal resuscitation (e.g. with bag and mask);
- A facility is classified as a Comprehensive Emergency Obstetric Care facility if it performs all the signal functions of a BEmOC facility plus [2]: surgery (e.g. caesarean section), and blood transfusion;
- CEmOC facilities are also considered to be BEmOC facilities as they are performing the 7 Basic EmOC functions as well;
- Would a complication requiring blood transfusion and/or surgery occur during the delivery in the BEmOC facility, the patient should be transferred to a CEmOC facility;
- It is considered that 15% of all births are to develop complications, and among them about 30% of complications (5% of all births) would require blood transfusion and/or C-section, and therefore a transfer from the BEmOC facility to a CEmOC facility;
- The maximum acceptable travel time from home to reach a BEmOC facility is 2 hours and this intends to account for:
  o The standard for the availability of services set to be between 2 and 3 hours in the 2009 hand book for monitoring emergency obstetric care [2]
  o In case of complications, especially haemorrhage, the estimated average interval between onset of a postpartum haemorrhage and death is set as being 2 hours [5]
- The maximum travel time considered in case of transfer between a BEmOC facility, where all women delivering should initially seek care, to a CEmOC facility because of severe complications is again of 2 hours (same rationale: time needed to address postpartum haemorrhage which is pre-managed at BEmOC facility but will require blood transfusion and/or C-section);

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[15] WHO (2004) Making Pregnancy Safer. The critical role of the skilled attendant. A joint statement by WHO, ICM and FIGO. http://whqlibdoc.who.int/publications/2004/9241591692.pdf

- The assumption is that women would walk or be carried from their home to the nearest road. This would take place during early labour (assuming that a birthing plan has been developed and that the woman has the support of her family to initiate care seeking as labour commences). At this stage in the delivery process a 50% reduction in walking speed is assumed. Upon reaching a road, women would then travel by motor vehicle to the nearest BEmOC facility. The analysis will include an alternative scenario where women are assumed to travel to the BEmOC facility by foot alone. This scenario is analysed to estimate the gains made by financially supporting women to be able to access road vehicle transportation;
- The transfer between the BEmOC facility to the CEmOC facility is done using a motor vehicle (ambulance, car, truck,…)
- Analyzes are performed considering transportation conditions during the dry season. While the tool used here (see Chapter 4) can account for areas and/or roads being flooded during the wet season, this particular context has not been analysed here;
- Based on a 90% target asset by the ICPD for 2015 [4], conditions that support universal accessibility and universal geographic coverage are assumed to be in place when:
    - 90% of all births in the country would be within 2 hours of travel from a BEmOC facility and that the capacity of the BEmOC facility, in terms of skilled birth attendants, is sufficient to cover the demand;
    - 5% of all births taking place in a BEmOC facility (considered as presenting complications) could be transferred to a CEmOC facility in less than 2 hours[16] and that the capacity of the CEmOC facility, in terms of EmOC facility surgical teams, is sufficient to cover the demand.

The above assumptions translate into the EmOC referral model presented in Figure 1.

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[16] We note that the assumption of a potential maximum 4 hours travel time (2 hours to skilled care and BEmOC and a further 2 hours to CEmOC) may be too long since there is a risk that in a small proportion of women with severe bleeding after a birth, blood transfusions and surgical treatment if required may be required sooner than that.
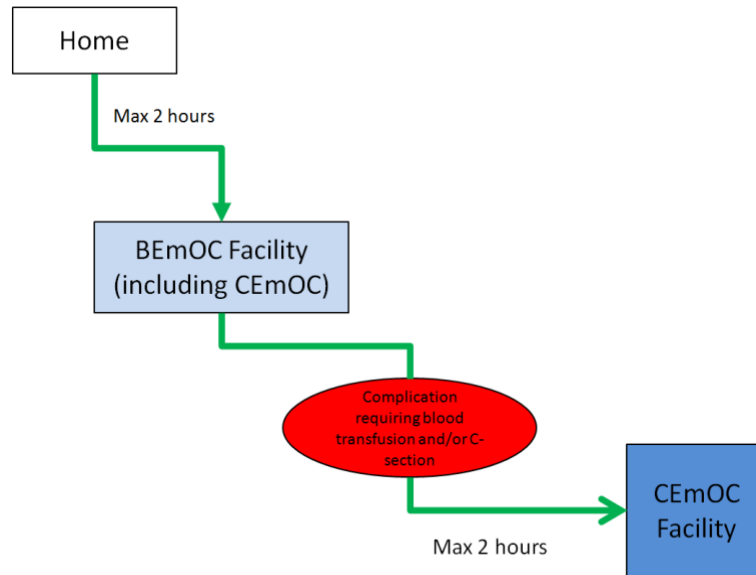
Figure 1 – EmOC referral model used in the context of the project

It is important to note here that this model, at present:
- Assumes that:
  o Women have enough resources to pay for the transportation on the road network;
  o A vehicle (ambulance, car, truck, etc,..) is available at each BEmOC facility for the transfer to a CEmOC facility in case of complications requiring blood transfusion and/or C-section.

- Does not consider:
  o The availability of waiting homes to allow for women living in remote areas to come close to an EmOC facility before the due date and therefore increase accessibility.

- Does not consider the following for the situation analysis (although it may be considered for the scaling up analysis):
  o Demand generation activities (where demand appears to be lower than supply);
  o Improving transport links (e.g., improving the quality of some roads) and the expected impact on accessibility.

These assumptions are essential in that actual perceived accessibility may in fact be lower than theoretical accessibility, if the women do not have access to road transportation.

The EmOC referral model used here may be adjusted to reflect the current country context. Attempts were made accordingly to reflect the current policy in Burkina Faso

(See Annex 3) and the possibility of making maternity waiting homes available was used in the scaling up analysis.

However, for the first phase of analysis as presented here the pathways to home deliveries and non-EmOC facilities as well as the use of waiting homes were not utilized in the model since the objective of the research is to show the current accessibility and availability of skilled care at birth including EmOC functions, and if needed to assess potential scale-up implications of expanding access to 90% target as set by the ICPD follow-up resolution.

The analysis could therefore be expanded to show additional pathways if this is considered appropriate.

4. Tool used for the different analysis: AccessMod 4.0

All analyzes conducted in the context of this project have been possible thanks to the use of AccessMod ©.

AccessMod© is a toolbox that has been developed by WHO to provide Ministries of Health, and other health partners, with the possibility to use the power of Geographic Information System (GIS) to:
- Measure physical accessibility to health care,
- Estimate geographical coverage (a combination of availability and accessibility coverage) of an existing health facility network,
- Complement the existing network in the context of a scaling up exercise or to provide information for cost effectiveness analysis when no information about the existing network is available.

AccessMod© uses the functions of Esri's GIS technology to apply a specific set of algorithms on a series of GIS layers containing the information influencing the time taken by a patient to reach the nearest health facility depending on the mode of travel (for example, by feet, by car, etc).

As GIS technology evolves, and to address needs specific to the present project, a new version of AccessMod (version 4.0) has been developed to work on a more recent version of Esri's technology, ArcGIS 9.3.1 software. This version of AccessMod is freely accessible either through the WHO [7] or Esri ArcGIS online [8] web sites and comes with a user manual and a sample dataset to guide users on the use of AccessMod's different modules, namely:
  - Module 1 to create the combined land cover distribution grid and the travelling scenario table on the basis of the land cover, road and hydrographic network layers;
  - Module 2 to measure the travelling time to or from for a given health facility network;

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- Module 3 to analyse the geographic coverage an existing health facility network through the generation of catchment areas and determination of the population covered by each of the facilities;
- Module 4 to determine the locations for new health facilities, and the population they cover, to scale up an existing network or to perform different analysis when no information about the location of the existing health facility networks is available (e.g. for cost-effectiveness analysis).

5. Analytical approach

The present project covers four specific analyses:

1. Accessibility coverage:
    a. The percentage of all births where the household is located within 2 hours of travel time of a BEmOC facility;
    b. The travel time between each BEmOC facility and the nearest CEmOC facility.
2. Geographic coverage:
    a. The percentage of all births where the household is located within 2 hours of travel time of a BEmOC facility with enough capacity to cover these births if normal delivery (i.e., with sufficient availability of skilled birth attendants);
    b. The percentage of births with complications requiring blood transfusion/Caesarean-section (C-section) that will reach a CEmOC facility within 2 hours of travel time from BEmOC facilities, and where the CEmOC facility has enough capacity to manage complications (through the availability of EmOC surgical teams).
3. Service utilization: Comparing results from the accessibility/geographic coverage analysis with data on actual service utilization (estimated capacity of BEmOC compared with the percentage of births delivered in a health facility; the estimated capacity of CEmOC compared with the number of caesarean-sections)
4. Scaling up: Scenarios developed to reach universal coverage through various mechanisms of expanding the EmOC facility network.

The objective, method and outputs for each of these analyses are described in more details in the following sections.

5.1 Accessibility coverage analyzes

Objective: Measure physical accessibility to EmOC facilities through the following data and indicators:

1.1 At the national and sub national level, the proportion of births located within 2 hours travel time from a BEmOC, including CEmOC, facility;

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1.2 The travel time between each BEmOC facility and the nearest CEmOC facility;

1.3 At the health facility level:

    1.3.1 The number and percentage of births reaching a BEmOC, including CEmOC, facility within 2 hours of travel time from their domicile;

    1.3.2 The number and percentage of births, among those requiring blood transfusion and/or surgery during delivery (estimated as 30% of the 15% of all births delivering in a BEmOC facility (rounded to 5%) that can reach a CEmOC facility within 2 hours travel time.

Method: The methodology takes into account the location of the BEmOC/CEmOC facilities, the environment that the patient will have to cross to reach the nearest care provider (including the hydrographic network as barriers), the road network as well as the following transportation scenarios:

- walking/carried outside of the road network and then a motor vehicle on the road network;
- Walking/carried only.

In this first analysis, as well as all the other subsequent ones, the total number of births is spatially distributed using the approach described in Section 6.2.8.

When it comes to the referral in case of complications requiring blood transfusion and/or surgery during delivery, patients are considered to be sent to the nearest CEmOC facility in terms of travel time.

Outputs:

1. Maps presenting the travel time to the nearest BEmOC facility (for two scenarios: walking only, and walking + motor vehicle on the road network);
2. Excel file presenting, at the country and sub-national level, the total number and percentage of births within 2 hours from a BEmOC facility (for two scenarios: walking only, and walking + motor vehicle on the road network);
3. Map presenting, at the sub national level the percentage of births within 2 hours of a BEmOC facility (walking + motor vehicle on the road network);
4. Excel file presenting the travel time between each BEmOC facility and the nearest CEmOC facility (use of motor vehicle);
5. Excel file presenting the min, max and mean travel time to the nearest BEmOC facility and between BEmOC facilities and the nearest CEmOC facility (through referral) for each sub national unit (one scenario only: walking + motor vehicle on the road network).

5.2 Geographic coverage analyzes

Objectives: Add the availability of human resources (skilled birth attendant, EmOC surgical team) and equipment (operating theatre) to the first analysis to identify potential gaps when it comes to reaching universal geographic coverage for the births where the household is located within 2 hours of travel time of the BEmOC facility (walking + motor vehicle on road network) and/or those transferred to a CEmOC facility in case of a complication requiring blood transfusion and/or a C-section during delivery.

Method: Geographic coverage analysis combines both availability and accessibility coverage into one unique measure.

The method used for this analysis therefore consists in:
- For BEmOC facilities:
  o Estimating the coverage capacity of each BEmOC facility by multiplying its total number of staff qualified to attend a normal delivery (skilled birth attendant) with the national, or WHO if the national one is not available (175 births per year per skilled birth attendant), workload norm;
  o Applying the third module of AccessMod (see Chapter 4) to define the catchment area of each BEmOC facility using the above estimated coverage capacity and 2 hours of travel time;
  o Verifying that more than 90% of all births are covered through this analysis to comply for universal coverage as defined in the context of this project.

In the context of this project, the processing order used when looking at geographic accessibility to BEmOC, including CEmOC, facilities is normally as follows:
- BEmOC facilities before CEmOC facilities [17] as the referral system should instruct patients to go to a BEmOC facility first, would they have a facility of each type within the same travel time,
- Decreasing order of the coverage capacity of each BEmOC facility (number of skilled birth attendant multiplied by the national or WHO (175 births per staff per year) workload norm. If the staffing information is not available, then by decreasing order of the population living within the immediate vicinity (5 km) of the facility to treat the most populated areas first.

Burkina Faso having only identified 4 facilities complying to BEmOC, these facilities being all part of the lowest level of referral and real figures regarding the

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[17] Births located within two hours travel time are attached to the closest facility. Only those births located within overlapping catchment areas can find themselves attached to a different facility depending on the order of treatment. By starting with BEmOC facilities we ensure that non-complicated births are first handled by BEmOC facilites before using the capacity of the CEmOC facilities. CEmOC facilities would then in a way complement the coverage capacity of BEmOC facilities for births located further away than 2 hours of travel time from a BEmOC facility but within 2 hours of travel time of a CEmOC facility.

number of births they covered in 2012 being available, it has been decided in the present case to define the processing order only on the basis of the decreasing order of the coverage capacity.

- For CEmOC facilities:
    o Using the results of the accessibility coverage analysis to identify the number of births that would be referred to each CEmOC facility considering that 5% of the births reaching a BEmOC facility would need to be transferred for blood transfusion and/or C-section;
    o Converting the corresponding total number of births transferred to each CEmOC facility into an expected number of EmOC surgical teams using the national workload norm or an estimated one if the national norm is not available;
    o When the information is available, comparing the expected number of EmOC surgical teams with the real number of teams observed in each CEmOC facility to identify potential gaps.

The following additional analysis can then be performed in case the total number of births delivered in each BEmOC facility and/or total number of C-sections performed in each CEmOC facility is available:
- For BEmOC facilities, comparing the modelled number of births with the real one to potentially identify facilities that are being by-passed by patients;
- For CEmOC facilities, comparing the modelled number of births needing C-section and/or blood transfusion with the real number of C-section to potentially identify problems in the referral system.

Given that the first part of the analysis is dependent on the existence of national EmOC norms as well as on health facility level data (number of skilled birth attendant for BEmOC facilities and number of EmOC surgical teams, including functional operating theatres, for CEmOC facilities), different options have to be considered to attain these data, namely:

1. For BEmOC facilities:
    1.1 When facility level data on skilled birth attendant and the national workload norm are available the full analysis as described here above can be performed directly;
    1.2 When facility level data on skilled birth attendant are available but not the national workload norm, the WHO benchmark of 175 births per skilled birth attendant is used (please note that this norm might be adjusted depending on the health facility type serving as a BEmOC facility to account for the fact that nurses/midwifes might not be working 100% of their time on maternal and newborn health services. Please refer to Annex 10 of the 2009 Cambodia EmOC improvement plan as a example [6]);
    1.3 When neither the national workload norm nor facility level data on skilled birth attendant are available, the maximum coverage capacity of each facility

> type is estimated in consultation with the Ministry of Health and WHO Country office and applied in the calculation.

2. For CEmOC facilities:

    2.1 When facility level data on existing operational EmOC surgical teams and the national workload norm are available the full analysis as described here above can be performed directly;

    2.2 When facility level data on existing operational EmOC surgical teams are available but there is national workload norm a benchmark is then estimated in collaboration with the WHO Country Office.

    2.3 When neither the national workload norm nor facility level data on existing operational EmOC surgical teams are available a benchmark is then still estimated in collaboration with the WHO Country Office.

It is important to mention here that the present analysis could be used to inform a potential adjustment of the national, or even international, workload norms for EmOC requirements.

Outputs:

1. Excel file containing separated worksheets for:

    a. The number of births covered by each BEmOC facility taking 2 hours of travel time and its respective coverage capacity into account. Real number of births will also be included in this worksheet if the information is available.

    b. At the national and sub-national level, the total number and percentage of births where the household is located within 2 hours from a BEmOC facility (walking + motor vehicle on the road network) and for which there is enough capacity to cover the demand. These figures are used to measure universal geographic coverage.

    c. The number of births referred to each CEmOC facility because of complications (5% of the births reaching the BEmOC facilities) with an estimation of the expected number of EmOC surgical teams needed to cover the demand. Real number of EmOC surgical team and real number of C-sections would also be included in this worksheet if the information is available.

5.3 Service utilization analyzes

Objective: Compare the actual utilization of services, with the theoretical accessibility and geographic coverage obtained in the first and second set of analyzes.

Method: Data collected in the context of the most recent DHS, or equivalent household surveys, are combined with the results of the first and second analyzes at both the cluster and sub national level to obtain a map and a graph allowing for the comparison.

Output:

For BEmOC, including CEmOC, facilities:
1. For countries where there is no DHS nor other equivalent survey data: no output will be possible in this case
2. For countries where a DHS or other equivalent survey data are available but for which the geographic location of the clusters of surveyed households are not available:

    2.1 Graph that compares, at the sub national level:
      2.1.1 the percentage of births that could have taken place in a BEmOC, including CEmOC, facility as within 2 hours of travel time (walking + motor vehicle on the road network) with the percentage of births delivered in a health facility (all levels) from DHS (e.g., in district X 75% of births have their household located within 2 hours access but only 45% of women had a delivery in a facility).
      2.1.2 the percentage of births that could have taken place in a BEmOC, including CEmOC, facility as within 2 hours of travel time from the household (walking + motor vehicle on the road network) and with enough capacity to cover the demand with the percentage of births delivered in a health facility (all levels) from DHS
3. For countries where geocoded DHS (or other georeferenced household surveys) data are available:

    3.1 Same graph as in point 2.1 here above;
    3.2 Map showing the spatial distribution of cluster level un-attended home deliveries from DHS on top of the 2 hours catchment area from the accessibility coverage analysis as well as the catchment areas obtained through the geographic coverage analysis

For CEmOC facilities:
4. For countries where there is no DHS, no other equivalent survey data and no EmOC level data on the number of C-sections performed for a recent year: no output will be possible in this case
5. For countries where DHS, or other equivalent survey, data are available but for which no EmOC level data on the number of C-sections performed over a recent year are available:

    5.1 Comparison between the sub national percentage of births with complications referred to a CEmOC facility as per the result of the geographic coverage analysis (5% of births covered in 2 hours by a BEmOC considered as referred to a CEmOC considering only the CEMOC facilities that are within 2 hours of reach), with the percentage of births delivered by C-section as per the DHS, or any other equivalent household survey, assuming that the C-sections reported in the DHS took place in certified CEmOC facilities (e.g. 75% of women needing C-sections had geographic access based on the analysis but only 45% of these C-sections took place in a CEmOC facility as per DHS survey data).

6. For countries where DHS, or other equivalent survey, as well as EmOC level number of C-sections performed over a recent year are available:
   6.1 Same comparison than the one presented in point 5.1;
   6.2 Comparison between the real number of C-sections performed in CEmOC facilities for a recent year and the number of C-sections referred by the model as part of the geographic coverage analysis.

5.4 Scaling up analyzes

Objective: Provide the necessary information to allow for an estimation of the cost to reach universal coverage in the country (90% of all births with geographic coverage and 5% of births delivering in BEmOC facilities to reach CEmOC facilities in less than 2 hours and having enough capacity to answer the demand).

Method: The method used for this analysis depends on the results of the geographic coverage analysis, namely:
1. If the results of the geographic coverage analysis shows that 90% of all births in the country can reach a BEmOC facility within 2 hours, that the concerned BEmOC facilities have enough capacity to answer the demand, that 5% of these births can reach a CEmOC facility in less than 2 hours in case of complications and that the concerned CEmOC facilities have the necessary capacity to answer the demand, then there is no need for scaling up physical access to care as the country is theoretically reaching universal accessibility and geographic coverage as per the definition used in the context of this project;
2. If the results of geographic coverage analysis shows that 90% of all births in the country can reach a BEmOC facility within 2 hours and that the existing BEmOC facilities have enough capacity to answer the demand but that *less than* 5% of these births can reach a CEmOC facility within 2 hours in case of complications and/or that the concerned CEmOC facilities do not have enough capacity to answer the demand then the present analysis will look at:
   a. Seeing if converting some of the BEmOC facilities into CEmOC ones and/or upgrading some facilities to perform CEmOC signal functions would bridge the gap;
   b. using AccessMod (See Chapter 4) to model the construction of additional CEmOC facilities until covering these 5% of births if necessary (for that, national norms or, if not available, estimated number of EmOC surgical teams and operating theatres for different types of health facilities will be used during the analysis).
3. If the results of accessibility coverage analysis shows that *less than* 90% of all births in the country can reach a BEmOC facility within 2 hours and/or that the concerned BEmOC facilities do not have enough capacity to respond to the demand, then the analysis will be completed in two phases:

a. The modelling assumes that the current BEmOC network will be expanded until reaching 90% of all births in the country by:
    i. Either looking at expanding the coverage capacity of existing BEmOC facilities;
    ii. Or upgrading some facilities to perform all 7 BEmOC signal functions;
    iii. Or using the AccessMod to model the construction of new BEmOC facilities if necessary (for that, national norms or, if not available, WHO norms regarding the number of births covered by skilled birth attendant per year will be used to determine different types of facilities to be considered in the analysis)
b. The geographic coverage analysis for CEmOC facilities will be conducted on the expanded BEmOC facility network obtained under point "a" to see if there is a CEmOC facility within 2 hours of travel time from each BEmOC facility and enough capacity in these CEmOC facilities to answer the demand:
    i. If this is the case, then these results would be used to provide the information for the cost analysis.
    ii. If this is not the case, then the network of CEmOC facilities will be expanded until reaching the 5% of the births covered by the network of BEmOC facilities following the steps reported in point 2 here above.

The results of this analysis will then be used to estimate the cost to reach universal geographic coverage.

Note: When the information is available, facilities that have been identified, through a recent EmOC assessment for example, as providing some but not all the EmOC functions will be used during the scaling up analysis and this because improving the quality of care in these existing facilities would incur a lower cost than the construction of new facilities. The analysis will thus differentiate between:
1. Number and location of facilities that would be upgraded.
2. Number and location of facilities that would be constructed

Output:

As mentioned here above, the outputs will depend on the results of the geographic coverage analysis:
- 1st case here above:
    o The files obtained from the geographic coverage analysis will be used as a reference but no cost analysis would be needed as the country is estimated to reach universal accessibility and geographic coverage;
- 2nd case here above:
    o Excel file containing the list of the new CEmOC facilities (converted BEmOC facilities and/or new facilities), including corresponding number of EmOC surgical teams and equipment that would need to be built to reach universal geographic coverage. The cost analysis would then be conducted on

the basis of the results of the geographic coverage analysis as well as this new file

- 3rd case here above:
  - o Excel file containing separated worksheets for:
    - i. The number of births covered by each BEmOC facility taking 2 hours of travel time and its respective coverage capacity into account. Real number of births will also be included in this worksheet if the information is available.
    - ii. The number of births referred to each CEmOC facility because of complications (5% of the births reaching the BEmOC facilities) with an estimation of the expected number of EmOC surgical teams needed to cover the demand. Real number of C-sections would also be included in this worksheet if the information is available.
  - o Map showing the location of the new BEmOC and CEmOC facilities on top of the existing ones.

These outputs will then be used to estimate the cost for scaling up the existing EmOC delivery system to reach universal geographic coverage as considered in the context of this project (Figure 1).

For the 2nd and 3rd case mentioned here above, the cost analysis would include the cost of commodities and supplies required, including blood transfusion for CEmOC facilities, as coverage is expanded and additional women are seen in EmOC facilities.

The outputs can also be used to evaluate the pertinence of the current UN indicators when it comes to the geographical distribution of EmOC facilities (Indicators 1 and 2 in Annex 2).

6. Data and national norms used in the different analysis

Performing the different analysis considered in the context of this project requires an important volume of data that can be grouped into three main categories:
- Statistical data,
- Geospatial data,
- National norms,

From a statistical point of view, data collected at different levels are being used, namely:
1. At the national level
    i. Total population and number of births;
    ii. Total and urban/rural Crude Birth Rate (CBR);
2. At the sub national level
    i. CBR or fertility rate if the CBR is not available;
    ii. Total population as well as breakdown by age groups and sex if using the fertility rate in (i);
    iii. Percentage of births delivered in all health facilities;
    iv. Percentage of births delivered by C-section.
3. At the cluster level (Household survey):
    i. Total number of non-assisted home deliveries.
4. At the health facility level:
    i. For BEmOC, including CEmOC, facilities:
        1. Number of medical staff qualified to attend normal deliveries (skilled birth attendant);
        2. If available, total number of normal deliveries over a recent year.
    ii. For CEmOC facilities:
        3. Number of operational EmOC surgical teams (meaning including functional operating theaters);
        4. If available, total number of C-sections operated over a recent year.

From a geospatial perspective, the different analysis requires to have the following GIS layers at disposal:
1. Administrative boundaries matching the level of desegregation of the sub national statistical data;
2. Geographic location of all the EmOC facilities based on the most recent assessment available,
3. Road network;
4. Hydrographic network (major rivers and water bodies);
5. Location and extension of the cluster for the household survey data;
6. Land cover including the extend of urban areas;
7. Digital Elevation Model (DEM);
8. Spatial distribution of the number of births.

In addition to these layers, a mosaic of satellite images has been used as ground reference to:
- evaluate the accuracy, and to some extend level of completeness, of the different layers
- insure consistency among the different source of GIS

The mosaic used in the context of this project has been collected through the Landsat ETM+ program and downloaded from the Earth Science Data Interface (ESDI) at the Global Land Cover Facility [9].

When it comes to national norms, the different analysis requires having the following in hands when they exist:
1. Acceptable workload for skilled birth attendant (SBA) in BEmOC facilities (i.e. number of births per SBA per year);
2. Acceptable workload for EmOC surgical teams in CEmOC facilities (An EmOC surgical team includes one surgeon, one nurse, one anesthesiologist as well as a functional operating theater (other functions might also be required but these are the minimum essential ones);
3. Maximum travel speed expected for a motor vehicle on the different types of roads observed in the country.

The following sections describes more in details the sources of the data and norms used for Burkina Faso as well as the potential preparation, adjustments or transformations that have been used to obtain the final dataset necessary to implement the different analysis described in Chapter 5.

It is important to emphasize here the temporal discrepancies that exist between the different datasets that have been used. While from a statistical perspective the project mostly used the 2010 data from the DHS [12] and the EmOC needs assessment [17], from a geospatial perspective the representativeness of some of the layers, mainly the road network and land cover, are difficult to estimate as the associated metadata is not available. A temporal shift is therefore possible between the two types of data and has to be taken into account when analyzing the results presented here.

In addition to that, the needs assessment used in the present study has been conducted back in 2010 (see section 6.1.4). The situation depicted here might therefore have changed, in terms of both the EmOC infrastructures and associated human capacities.

Apart from that, additional data are also necessary for conducting the subsequent cost analysis but these are not detailed here as the costing is not part of the analysis being conducted so far. Such analysis would require data on costs for commodities, supplies, human resources, equipment, upgrade/maintenance and construction costs for facilities, depending on the strategies elected for the scale-up analysis.

6.1 Statistical data

6.1.1 National level figures

To ensure a certain level of comparability between countries that are part of this project it has been decided to use the 2011 medium variant of the total national population produced by the United Nations, Department of Economic and Social Affairs in its 2010 revision [10]. In the case of Burkina Faso, this corresponds to a population of 16,968,000 inhabitants.]

Along the same line, the total number of births reported in the 2011 State of World's Midwifery report from UNFPA [11] has been used as a reference to crosscheck the total number of births estimated at the sub national level. For Burkina Faso, the total number of births reported in this report for 2008 is of 718,000.

When it comes to the total as well as urban/rural Crude Birth Rate (CBR) these have been obtained from the 2010 Demographic Health Survey (DHS) [12] and shows as follow:
- Urban : 33.3
- Rural: 43.3
- Total: 41.2

6.1.2 Sub national level figures

Province level CBR data for Burkina Faso are available from the 2006 population census [13] (Annex 4).

The Regional level fertility rate has been estimated in the 2010 DHS [12] (Annex 4).

While the later source is more recent, the Province level CBR data were preferred in the context of this project because they allow going to a lower level of desegregation and originate from a comprehensive census rather than a household survey.

This being said, the CBR decreased in the country since 2006 as we can see in Figure 2 created based on figures from the CIA World Fact Book [15].

Applying the 2006 CBR to the 2011 population data would therefore have resulted in considering too many births in the different analysis conducted here.

It was therefore decided to adjust the Province level CBR figure from the 2006 population census [13] to match a national CBR closer to the values we could find in the literature for the 2010-2011 period.
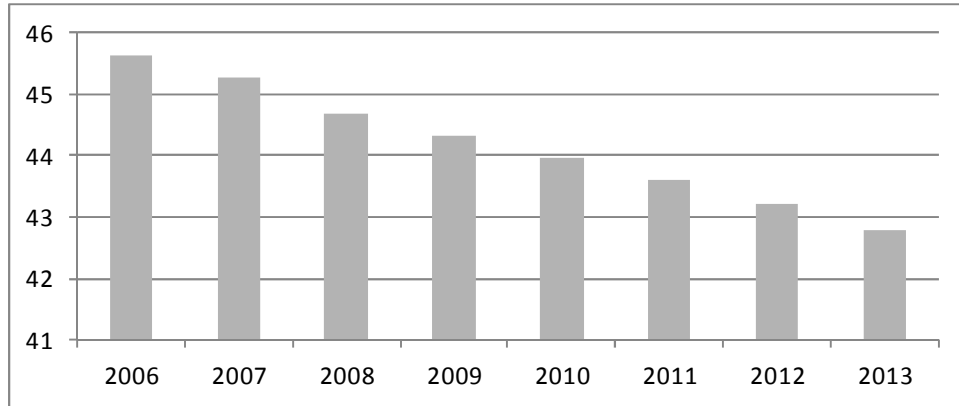
Figure 2 – Evolution of the national CBR in Burkina Faso from 2006 to 2013 (Extracted from [15])

While different estimations are available for 2011 (CIA world fact book [15]: 43.59; World Bank [16]: 42.91) it was agreed to use the figure from the 2010 DHS (see previous section). The reason for the choice is that this is the only recent study that also provides a urban-rural breakdown, information which is important here as it explains a big part of the sub national heterogeneity when it comes to the CBR.

The estimated number of births for 2011 has therefore been obtained through the following process (results reported in Annex 4):
1. The 2006 Province level CBR from the population census has been adjusted to obtain a national CBR of 41.2 (2010 DHS figure). This has been done considering that the evolution of the CBR was homogeneous over the 2006-2010 period and over the all country;
2. The 2006 Province level total population from the population census has been adjusted to the national UN population for 2011 [10]. That has been done considering an homogeneous growth rate over the 2006-2011 period for the whole country;
3. The Province level number of births for 2011 has been obtained by applying the adjusted CBR resulting from step 1 on the 2011 adjusted population resulting from step 2. This gives a total of 699,735 births at the national level for that particular year;
4. The Province level figures have been aggregated to obtain the Regional level number of births for 2011.

The Province level breakdown of the population by sex as well as the Regional level breakdown by specific age groups are also reported in Annex 4 for information.

Please note that the Region and Province level names reported in this annex are those provided by the Burkina Geographic Institute (Institut Géographique du Burkina) in the context of the Second Administrative Level Boundaries (SALB) dataset project [14]. The Region and Province level codes are those generated in the context of this project as well, these are therefore not official codes from the country.

Additional sub national figures concerns the Regional level percentage of live births in the five years preceding the survey delivered in a health facility (Table 3) and percent of live births in the five years preceding the survey delivered by cesarean section in a public or private facility (Table 4) as collected during the 2010 DHS [12]. In the case of the C-sections, the figures are unfortunately not desegregated according to the sector, public or private, of the facility.

Region	Percentage delivered in a health facility (all level)		
	Public sector	Private sector	Total
Centre	85.6	10.9	96.5
Boucle du Mouhoun	64.1	0.0	64.1
Cascades	76.6	0.1	76.6
Centre-Est	83.7	0.1	83.9
Centre-Nord	69.5	0.0	69.5
Centre-Ouest	59.5	0.0	59.6
Centre-Sud	84.9	0.3	85.2
Est	50.9	0.1	51.0
Hauts Bassins	74.4	0.4	74.8
Nord	61.7	0.0	61.7
Plateau Central	81.1	0.0	81.1
Sahel	35.3	0.0	35.4
Sud-Ouest	42.5	0.0	42.5
Nation wide	65.3	1.0	66.3

Table 3 – Regional percentage of live births in the five years preceding the survey delivered in a health facility, public or private [Extracted from 12]

Region	Percentage delivered by C-Section
Centre	8.2
Boucle du Mouhoun	1.6
Cascades	1.1
Centre-Est	1.2
Centre-Nord	0.6
Centre-Ouest	1.5
Centre-Sud	2.5
Est	0.9
Hauts Bassins	2.7
Nord	1.6
Plateau Central	1.8
Sahel	0.2
Sud-Ouest	0.7
Nation wide	1.9

Table 4 – Regional percent distribution of live births in the five years preceding the survey delivered by cesarean section in a public or private facility [Extracted from 12]

6.1.3 Cluster level figures

The cluster level number of non-assisted home deliveries was also obtained from the 2010 DHS [12]. In this case, the figures have been extracted from the original record dataset and aggregated to the cluster level using the following process:

1. The original record dataset has been obtained from MEASURE DHS;
2. Table BR61SV-BirthsRecode part of this dataset has then been used for the rest of the process;
3. The following indicators have been extracted from the BR61SV-BirthsRecode table:
   - CASEID   Case Identification
   - V001   Cluster number
   - M3A   Assistance: doctor, medical assistant
   - M3B   Assistance: midwife
   - M3C   Assistance: nurse
   - M15   Place of delivery
4. All the deliveries which did not take place at home were removed from the dataset. Records were kept for which the Place of Delivery indicator (M15) is either equal to 10 (Homes), 11 (Respondent's home) or 12 (Other home)
5. Records presenting the following values for the 4 other indicators where then kept:
   - Assisted by doctor, medical assistant M3A = No
   - Assisted by nurse, M3B = No
   - Assisted by midwife, M3C = No
6. The remaining records were then summed by cluster ID to obtained the cluster level number of non-assisted home deliveries.
7. Clusters for which the geographic location (latitude/longitude) was missing have been removed from the dataset.

The final dataset contains 4,339 unattended births spread among 402 clusters distributed over the all country (see map in Section 6.2.7).

6.1.4 Health facility level figures

This project considers public facilities for which the signal functions used to identify basic and comprehensive emergency obstetric care services as defined in the 2009 handbook [2] have been confirmed through either an assessment or the Ministry of Health.

In the case of Burkina Faso, the list of EmOC collected as part of the obstetrical and neonatal care emergency needs assessment conducted between June and August 2010 over the whole country was used [17]. During this assessment, a total of 1982 functional structures of care were visited, namely: 3 national hospitals (CHN), nine Regional hospitals (CHR), 49 medical centres with surgical antenna (CMA) (43 public, 1 private

for-Profit, 3 NGO / Association, 2 private confessional), 52 medical centres (MC), 1520 health and social promotion centres (CSPS), 61 clinics, 9 polyclinics and 141 nursing care practices. Based on the information available from the Ministry of Health web site[18], all the health facilities in the country at that time have been covered, the assessment is therefore comprehensive.

Facilities for which the 7 (BEmOC) or 9 (CEmOC) signal functions had been observed during the 3 months prior to the survey have been considered in the context of the present project. This concerns 4 BEmOC facilities and 21 CEmOC facilities presented in Annex 5.

Please note that, while the fiche number is a code used by the Ministry of Health, the EmOC code reported in Annex 5 does not correspond to an official code but a temporary one used in the context of this project.

When it comes to the different data needed at the health facility level (see beginning of Chapter 6) the following information have been obtained from the Ministry of Health for all the EmOC considered in the different analysis (Annex 6):
- Number of skilled birth attendants from the 2010 EmOC assessment [17]. This covers the following types of staff: Auxiliary midwifes, patented midwifes, state midwifes, nurses specialized in nursing and midwifery, patented nurses, registered State nurses and general practitioner;
- Number of medical staff qualified to perform a C-section from the 2010 EmOC assessment [17], namely: emergency physicians, gynecologists, general surgeon and nurses specialized in surgery;
- Number of medical staff qualified to perform an anesthesiology also from the 2010 EmOC assessment [17], namely: anaesthetistsand nurses specialized in anesthesiology;
- 2012 Number of assisted deliveries from the Ministry of Health for 24 of the 25 facilities.

At the same time, the following information have also been obtained for the same year from the Ministry of health for the 21 CEmOC facilities part of the present project (Table 5):
- Number of operating theatres derived from the 2010 EmOC assessment [17]. It has been considered that the facility was having two operating theatres when mention was made of a distinct one for obstetric services. In the other cases, it has been considered that the facility was having only one theatre.
- 2012 number of births delivered by C-sections for 18 of the 21 CEmOC facilities.

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[18] http://www.sante.gov.bf/

EmONC Code	Fiche number	EmONC Type	Facility name	Operating theatre (Salle bloc opératoire) [17]	Number of births delivered by C-sections (MOH, 2012)
C20	3436	CEmONC	CHR de Banfora	2	390
C13	3807	CEmONC	CHR de Dedougou	1	270
C19	2931	CEmONC	CHR de Fada	1	344
C8	4713	CEmONC	CHR de Gaoua	1	277
C21	1135	CEmONC	CHR de Kaya	2	424
C14	1628	CEmONC	CHR de Koudougou	2	653
C7	3222	CEmONC	CHR Dori	1	204
C18	4420	CEmONC	CHU Souro Sanou	2	944
C4	6402	CEmONC	CHU Yalgado Ouedraogo	2	4382
C10	720	CEmONC	Clinique Kone Moussa	1	*NA*
C3	4026	CEmONC	Clinique Lorentia	1	*NA*
C6	4623	CEmONC	CMA de Diebougou	1	110
C1	4123	CEmONC	CMA de Do	2	306
C2	4215	CEmONC	CMA de Hounde	1	283
C12	1225	CEmONC	CMA de Kongoussi	1	139
C9	4007	CEmONC	CMA de Orodara	1	348
C15	3627	CEmONC	CMA de Solenzo	1	421
C5	3733	CEmONC	CMA de Tougan	1	160
C17	2328	CEmONC	CMA de Zorgho	2	367
C16	24	CEmONC	CMA du secteur 26	1	*NA*
C11	417	CEmONC	CMA du secteur 30	1	738

Table 5 – 2010 number of operating theatres [17] and 2012 number of births delivered by C-sections in CEmOC facilities

6.2 Geospatial data

To ensure compatibility between the different sources of GIS data, and in order for AccessMod to produce correct results, all the GIS data presented in this section have been homogenized in terms of projection and spatial resolution (for GIS data in raster format).

When it comes to projection, it has been decided to use the Universal transverse Mercator (UTM) projected coordinate system as the data needs to be projected in a metric system when using AccessMod. In this system, Burkina Faso finds itself in between two zones, zone 30 and 31. As more than 85% of its surface finds itself in zone 30 it has been decided to use this one. Here are therefore the different elements that define this particular projected coordinated system when it comes to this zone as they appear in Esri's GIS software:

- Projected Coordinate System: WGS_1984_UTM_Zone_30N
- Projection: Transverse_Mercator
- False_Easting: 500000.00000000
- False_Northing: 0.00000000
- Central_Meridian: -3.00000000
- Scale_Factor: 0.99960000
- Latitude_Of_Origin: 0.00000000
- Linear Unit: Meter

The geographic coordinate system on which the UTM system is based is the following:
1. Geographic Coordinate System: GCS_WGS_1984
2. Datum: D_WGS_1984
3. Prime Meridian: Greenwich
4. Angular Unit: Degree

The spatial resolution of the GIS data in raster format used in this project (land cover, DEM and birth distribution) has itself been decided based on two criteria:
1. The resolution of the freely available data for the concerned layers;
2. The volume of RAM memory in the computer used for performing the different analysis as this is unfortunately one of the limiting factor when using AccessMod.

In view of the above, the spatial resolution finally used is of 1 km when the data is unprojected. This corresponds to 924.8332272 meters for Burkina Faso once projected according to the above-mentioned projected coordinate system.

924 meters is to be considered as a low resolution that induces an important simplification of the reality when performing the different analysis in AccessMod.

As an example, a road, which in reality would seldom be wider than 10 meters, would be presenting a width of 924 meters during the different analysis. This has two major implications:
1. The traveling speed within the cells crossed by road segments would be higher than in the reality for patients on their way to the road as the model would consider the patient to be travelling by road over the whole surface of these cells while she would normally still have to cross some lands by feet before reaching the road;
2. When roads are located along rivers the combination of the layers in AccessMod might result into the creation of "artificial passages" and therefore potential crossover that do not exist in the reality.

While it has been possible to make some adjustments in the road and hydrographic GIS layers regarding the second point (see Section 6.2.5) nothing could unfortunately be done when it comes to the first one.

Because of this, catchment areas obtained with AccesMod tend to be a little bit bigger than what they would be in reality. This said, it is difficult to quantify this error (see AccessMod user manual for some figures), although it is assumed that the size of this error is likely to be much smaller than potential uncertainties generated by some of the other assumptions made in the context of this project.

Taking the above into account, the following sections describe more in detail the source of the GIS data used in the context of this project as well as the modifications performed on them before conducting the different analysis described in Chapter 5.

6.2.1 Administrative boundaries

In order to be able to use the Region and Province level demographic data (Annex 3) and other data collected in the context of this project (see section 6.1.2) it was necessary to have access to a GIS layer containing the boundaries of these Regions and Provinces.

The layer in question has been obtained from the Geographic Institute of Burkina Faso, who is the National Mapping Agency, though the SALB project [14] and contains the delimitation of the 13 Regions (Figure 3a) and 45 Provinces (Figure 3b) observed in the country since August 2001.

a)

b)

Figure 3 – Region (a) and Province (b) boundaries used in the different analysis

6.2.2 Geographic location of the EmOC facilities

The geographic location of the EmOC facilities considered in the present study have been obtained from the 2010 needs assessment [17]. As they have been collected in decimal degrees, they have been reprojected according to the projected coordinate system described at the beginning of Section 6.2 (Figure 4).
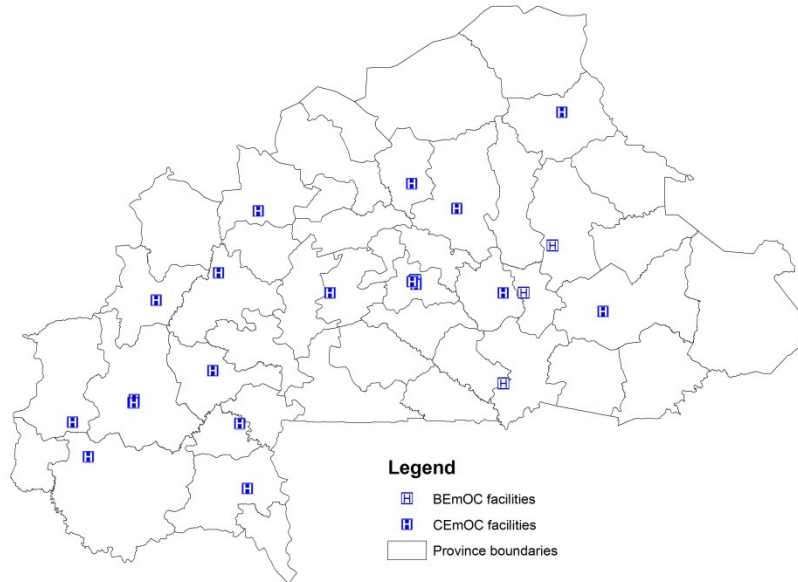
Figure 4 – Location of the EmOC facilities used in the different analysis

It is important to mention here that the position of some of these facilities has been modified manually at the time of using AccessMod in order to account for the spatial resolution used in the context of this project. This modification has been done to keep the consistency among the different objects (roads, rivers and health facilities) and to avoid having health facilities located in areas covered by water.

6.2.3 Land cover including the extend of urban areas

This project used the freely accessible 1 km resolution global land cover distribution grid developed in the context of the Global Mapping project by the Geospatial Information Authority of Japan, Chiba University and collaborating organizations using satellite images collected in 2003 [18].

In order to consider land cover classes pertinent to patient movements outside of the road network, the original classification has been simplified as per the table reported in Annex 7.

The other change operated was to integrate the extend of urban areas from the Global Rural-Urban Mapping Project (GRUMP) [19] into the original land cover layer where

this particular class is not well identified. This integration has been done following the process reported in Annex 8. Figure 5 presents the map resulting from this process.
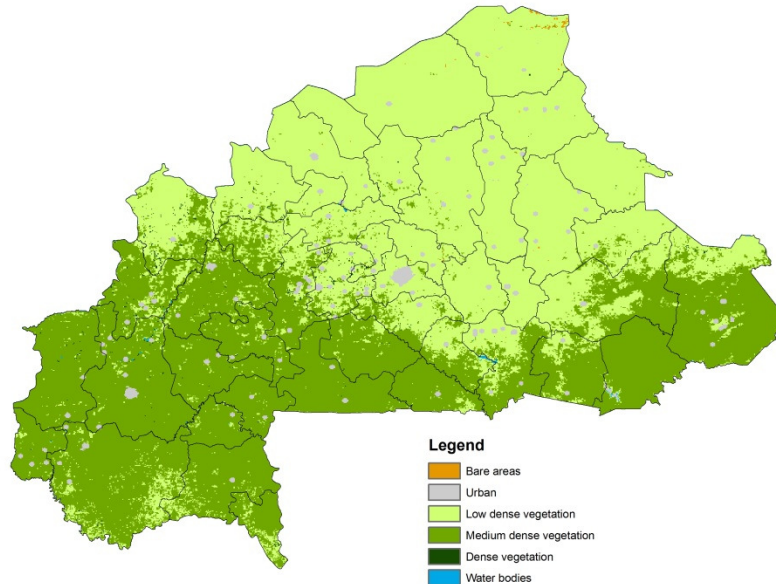
Figure 5 – Land cover distribution layer used in the different analysis

6.2.4 Road network

The freely available OpenStreetMap road network dataset, available on a country-by-country basis through the CloudMade web site [20], has been used.

The following changes and adjustments have been implemented on the original dataset in order to make it fit the purpose and spatial resolution of the project:

1. the segments from the following categories have been removed as not relevant for the transportation scenario decided for the project (see: http://wiki.openstreetmap.org/wiki/Key:highway for detailed description of each category): cycle way, footway, pedestrian, track, steps and services;
2. The segments categorized as "links" have been attributed to the corresponding main category as the differentiation was not relevant for the analysis ("primary link" attributed to "primary" and "trunk link" to "trunk");
3. Segments categorized as trunk were reclassified into primary roads and those categorized as residential into urban roads;
4. The segments not categorized were attributed a road type based on the following:
   - Road map of Burkina Faso: http://www.izf.net/pages/burkina-faso/4642/ [Accessed June 24, 2013]
   - The road network visible from Google map: https://maps.google.ch/maps
   - Considered as urban roads in urban areas or tertiary roads in rural areas

At the end of this process, the resulting map (Figure 6) contains the following road categories: primary road, secondary road, tertiary road and urban road.
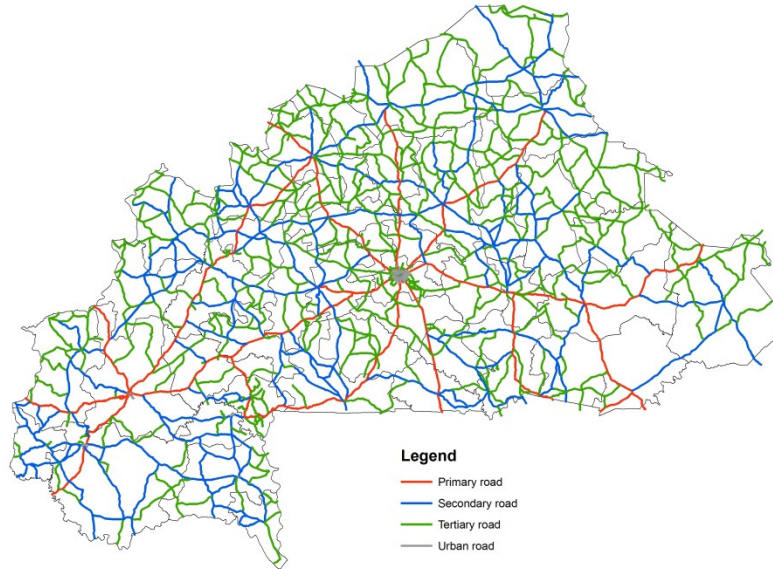
Figure 6 - Road network layer used in the different analysis

6.2.5 Hydrographic network

By lack of appropriate local dataset, the hydrographic network layers (both lines and polygons) coming from the 2009 edition of the Global Insight plus proprietary database [21] have been used (Figure 7).

Because of the low resolution used in the context of this project (around 924 meters) adjustments have then been made on this layer in order to ensure that once converted into raster format in AccessMod the road network was not generating any artificial passages in the dataset.

This has been done by combining the land cover (Figure 5), road (Figure 6) and hydrographic network (Figure 7) layers using the first module of AccessMod and then manually correcting areas where these artificial passages where appearing.

Figure 8 gives an example of the type of corrections that have been implemented in order to keep the consistency between roads and rivers, namely:
-   In Figure 8a two artificial passages (red arrows) have been created by the overlap of the road network converted into raster cells (in green) over the river network (in white) while the original vector layers (lines) clearly shows that there are no existing crossover between the left and right side of the river;
-   To correct this, a buffer equivalent to 1.7 time the resolution of the grid has been created around the road network (blue area on Figure 8b). The river segments located within this buffer have been manually moved outside its surface to adjust for the overlap (light blue line on Figure 8c)

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- Once the first module of AccessMod applied on the modified layer created under the previous step we can see on Figure 8d) that the two artificial passages are not there anymore and that the river is therefore playing its role of barrier to movement.
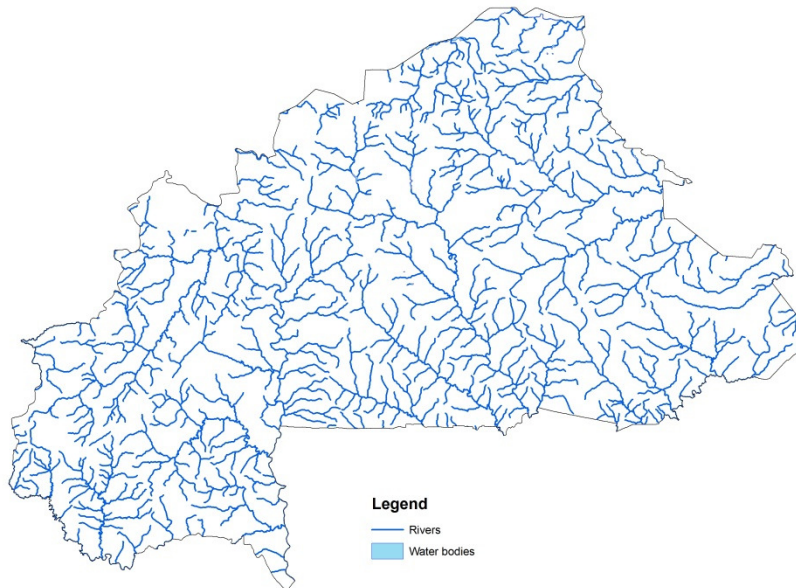
Figure 7 – Hydrographic network layer used in the different analysis
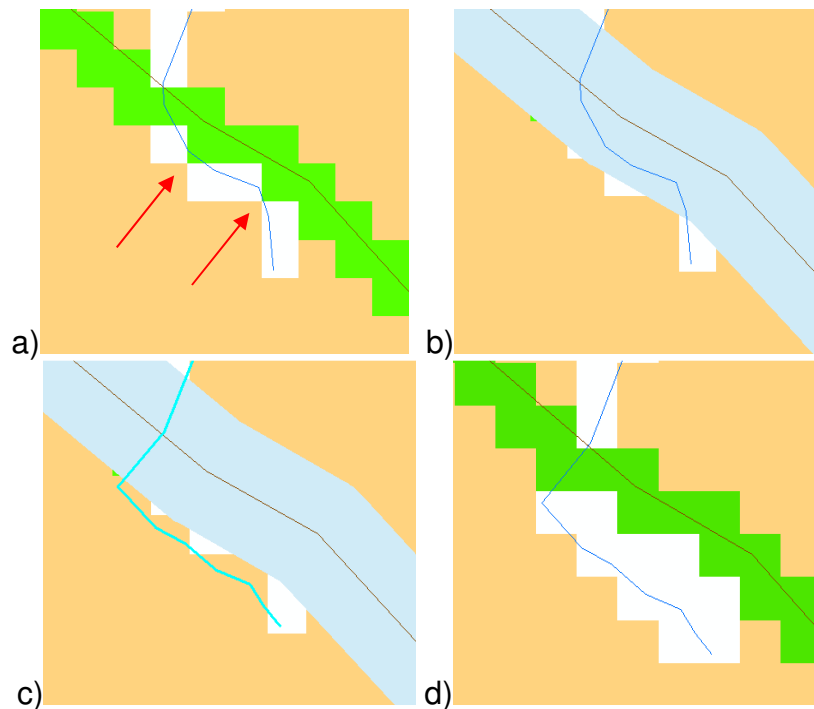
Figure 8 – Example of correction made on the river network layer to keep the consistency between the road and the hydrographic network

6.2.6 Digital Elevation Model

The freely accessible 1 km Shuttle Radar Topography Mission (SRTM) dataset produced in 2000 by the NASA in collaboration with other institutions [22] has been used without performing any changes on the original dataset (Figure 9).
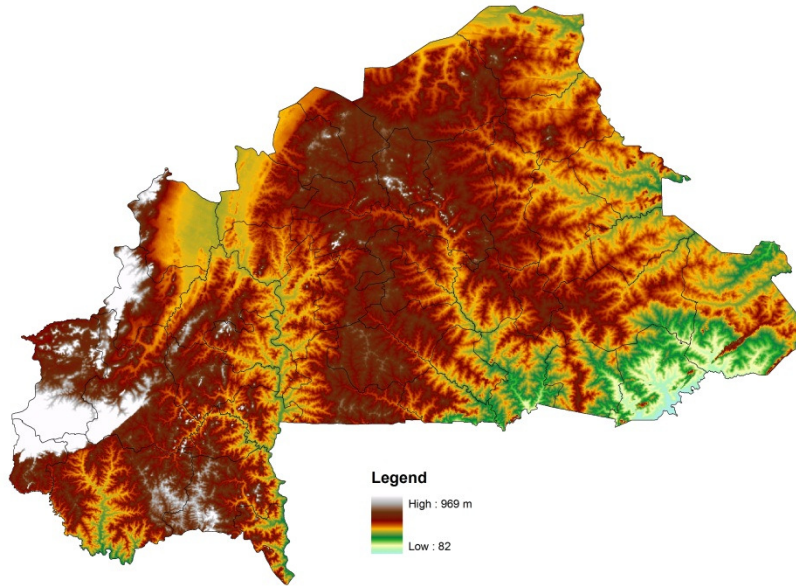
Figure 9 – Digitial Elevation Model (DEM) used in the different analysis

6.2.7 Spatial distribution of unattended home deliveries

The 2010 Demographic Health Survey (DHS) [12] covered 573 clusters spread all over Burkina Faso but information on non-assisted home deliveries was available for only 402 of those having a geographic location (Figure 10).

For confidentiality reason, MEASURE DHS is randomly shifting the location of these clusters (5 kilometers in rural areas and up to 2 kilometers in urban areas) and a further 1 percent of all rural clusters are also being displaced randomly for a distance going up to 10 kilometers.

In view of the above, and in order to account for the surface of the cluster (information not provided by DHS), it has been decided to represent the number of non-assisted home deliveries as random dots within a 5 km (urban areas) and 10 km (rural areas) radius buffer around the original DHS cluster location. These buffers have been created and adjusted to avoid having any points outside the country or on water areas using the process presented in Annex 9.

Once this done, a special function in ArcGIS has been used to randomly distribute dots within these buffers (one dot per unattended home delivery) (Figure 11).
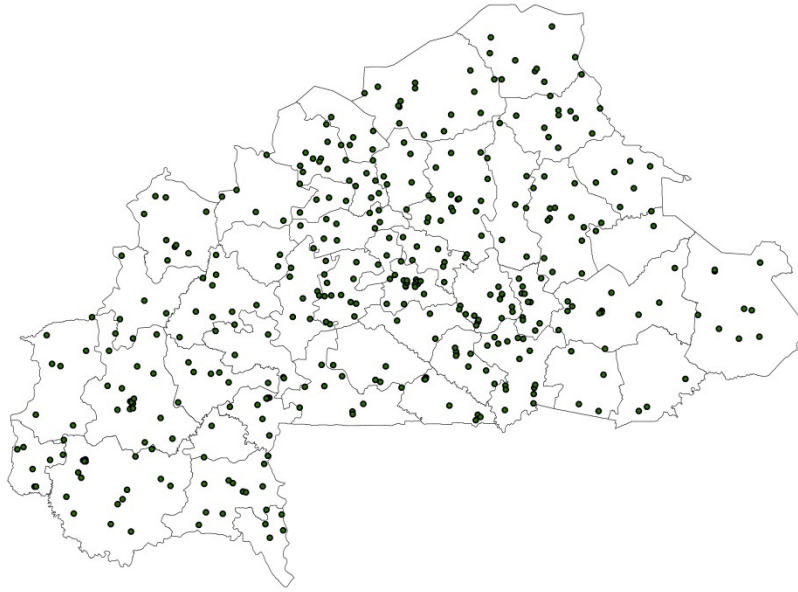
Figure 10 - Spatial distribution of the 402 clusters from the 2010 DHS
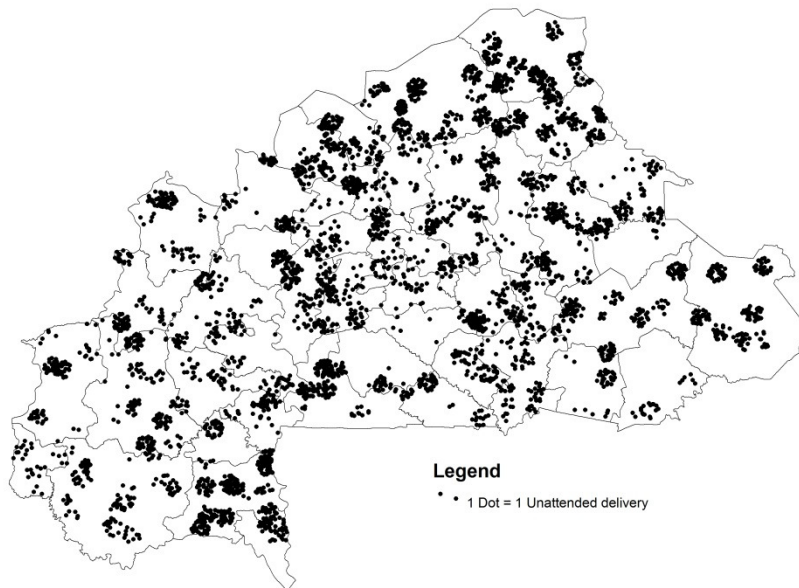
Figure 11 - Spatial distribution of the unattended home deliveries

6.2.8 Spatial distribution of the number of births

When using AccessMod, there is a need to spatially distribute the number of births down to the resolution of the other projected GIS layers (around 924 meters in the case of Burkina Faso).

This has been done using the Province level number of births estimated for 2011 (see section 6.1.2 and Annex 4), a population distribution grid as well as the process described in Annex 10. Through this process, no births are being placed on water bodies nor on areas that would be out of reach as per the result of the accessibility coverage analysis (see Figure 13).

A population distribution grid is a modeled spatial distribution of the population down to a certain level of desegregation or resolution. Such model provide a picture of the probability for the population to be located in a given part of the country based on some criteria such as, but not limited to: distance to the road network, slope,…. The geographic expression of this probability is what is being used here to obtain the final spatial distribution of the number of births in the country.

In the context of this project, the 2008 edition of the proprietary Landscan population distribution grid [23] has been preferred over other free datasets such as the Gridded Population of the World (GPW) [24] or WorldPop project [25]. The reason for this choice is linked to the spatial resolution of the Landscan dataset (1 km) and to the approach being used to generate this dataset as it provides more homogeneity from one country to the other than the WorldPop datasets. Figure 12 presents the resulting birth distribution grid that has been used in the different analysis conducted in the context of the present project.
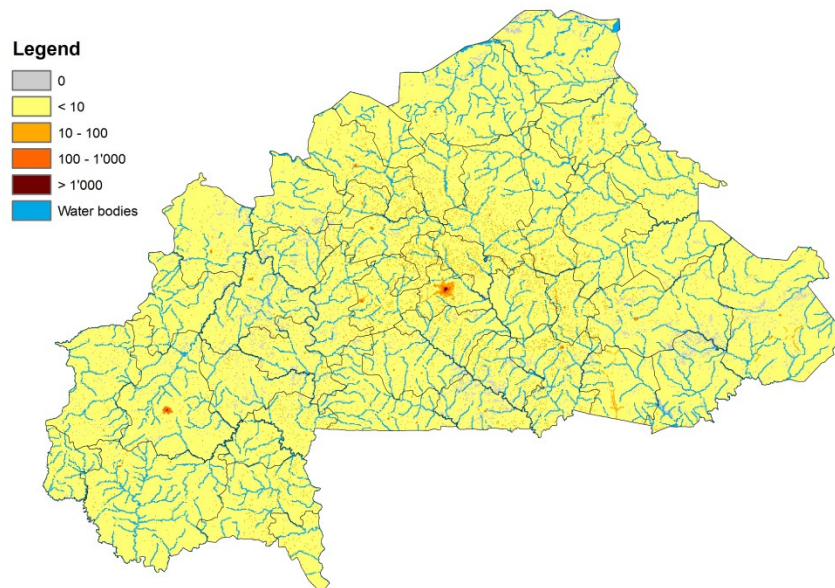
Figure 12 – Spatial distribution of the number of births used in the different analysis

6.3 National norms

Two different sets of national norms are needed to produce the outputs listed in Chapter 5, namely:
- The maximum acceptable workload for:
  o skilled birth attendants in BEmOC facilities;
  o EmOC surgical teams in CEmOC facilities;
- The maximum speed expected on the different road types observed in the country

Regarding the first set of norms, the absence of a national norm for the maximum acceptable workload for both skilled birth attendants in BEmOC and EmOC surgical teams in CEmOC required the establishment of some benchmarks in consultation with the WHO Country Office in Burkina Faso.

In the case of skilled birth attendants, the standard WHO assumption of 175 births per skilled birth attendant per year was applied (see World Health Report 2005). This assumes that the medical worker is working full time on providing a full package of MNH care which may be the case in the highest level of referral (Regional or University hospitals).

In lower level facilities, this norm has been adjusted to account for the fact that this type of staff would most likely be spending some of their time on other tasks.

In lower level facilities, this norm has been adjusted to account for the fact that this type of staff would most likely be spending some of their time on other tasks.

As a result of the above, the following norms were used in the context of the present project depending on the type of EmOC facility:
- 175 for CEmOC being Regional (CHR) or University hospitals (CHU),
- 100 for other CEmOC facilities (Medical centers with surgical antenna, CMA),
- 75 for BEmOC facilities (CM and CSPS).

These figures have been used as the reference to identify how many normal deliveries each BEmOC could cover based on its number of skilled birth attendant when performing the geographic coverage analysis (see section 7.2).

When it comes to EmOC surgical teams, and waiting to have a more official figure, it has been considered that the maximum acceptable workload for such teams would be of 60 births with complications per year [Communication from Dr Léopold Ouedraogo].

Regarding the second set of norms, it has unfortunately not been possible to find national norms regarding the maximum speed expected on the different road types observed in the country.

Starting from the WHO 2009 global status report on road safety [26] which indicates a maximum speed of 50 km/h on urban roads for Burkina Faso, and using inputs received from people living in the country, a maximum expected speed for each type of road (Figure 6) has been identified (Table 6).

In addition to this, following the assumptions considered in this project (see Chapter 3), the maximum traveling speed for a pregnant woman walking in her last month of pregnancy (estimated as 50% of the speed of a woman not being pregnant, i.e. 2.5 km/h in an open area) has been attributed for each land cover class considered here (Figure 5). These speeds are also reported in Table 6.

Land cover/ road type	Maximum speed (km/h)	Transportation media
Bare areas	2.5	Feet
Urban	2.5	Feet
Low dense vegetation	2	Feet
Medium dense vegetation	1.5	Feet
Dense vegetation	1	Feet
Primary road	80	Vehicle
Secondary road	70	Vehicle
Tertiary road	60	Vehicle
Urban road	50	Vehicle

Table 6 – Maximum travel speed on the different land cover and road types considered in the different analysis

Please note that movement by boat have not been considered in the context of this project while this transportation media might be used in Burkina Faso.

7. Results

This Chapter presents the results obtained for each of the analysis described in Chapter 5.

7.1 Accessibility coverage analyzes

This set of analyzes looks at measuring how the BEmOC, including CEmOC, facilities are accessible, in terms of travel time, to the population and how fast can a patient be transferred from a BEmOC facility to the nearest CEmOC facility in case of complications requiring a C-section and/or blood transfusion.

These analyzes have been performed using the following GIS layer and associated data described in the previous Chapter:
1. Location of the EmOC facilities (see Section 6.2.2);
2. Road network (see Section 6.2.4),
3. Hydrographic network (see Section 6.2.5),
4. Digital Elevation Model (DEM) (see Section 6.2.6),

5. Land cover (see Section 6.2.3)
6. Province boundaries (see Section 6.2.1)
7. Births distribution (see Section (6.2.8)
8. The following travelling scenarios
    a. From home until the nearest BEmOCfacility:
        i. Pregnant woman walking or being carried until reaching a road and then taking a motor vehicle
        ii. Pregnant woman walking or been carried only
    b. Between the BEmOC facility and the nearest CEmOC facility in case of complication:
        i. Use of a motor vehicle
9. The maximum travelling speeds reported in Table 6.

The first module of AccessMod has then been used to generate the combine land cover and scenario file and have the maximum travelling speeds reported in Table 6 integrated into it.

These two files, the DEM as well as the location of the BEmOC, including CEmOC, facilities have then been used as the input data for the second module of AccessMod.

The first result coming out of this module is the spatial distribution of the travel time to the nearest BEmOC, including CEmOC, facility when considering that pregnant women are walking, or being carried, until reaching a road and then taking a motor vehicle until the facility (Figure 13).
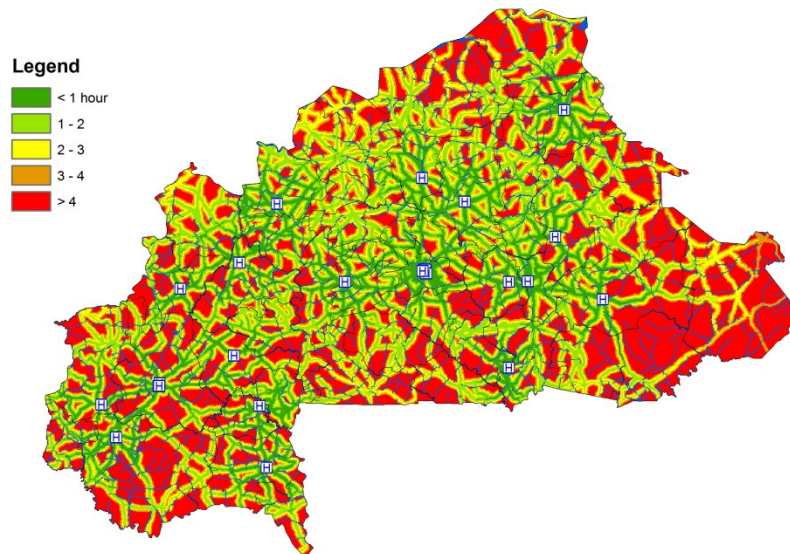
Figure 13 – Travel time to the nearest BEmOC facility considering that pregnant women are walking, or being carried, until reaching a road and then taking a motor vehicle until the facility

The traveling scenario table has then been modified to consider that women would only be walking or being carried until the nearest BEmOC facility. In this case, the maximum

speed on any road was considered to be of 2.5 km/h. Figure 14 presents the results when using this scenario.

What we can directly see from Figure 13 and 14 is that the possibility to travel by a motor vehicle once reaching the road network has a very important positive impact on accessibility coverage. This confirms the importance of any programs aiming to facilitate the timely transportation of pregnant women to the nearest EmOC facility at the moment of delivery.
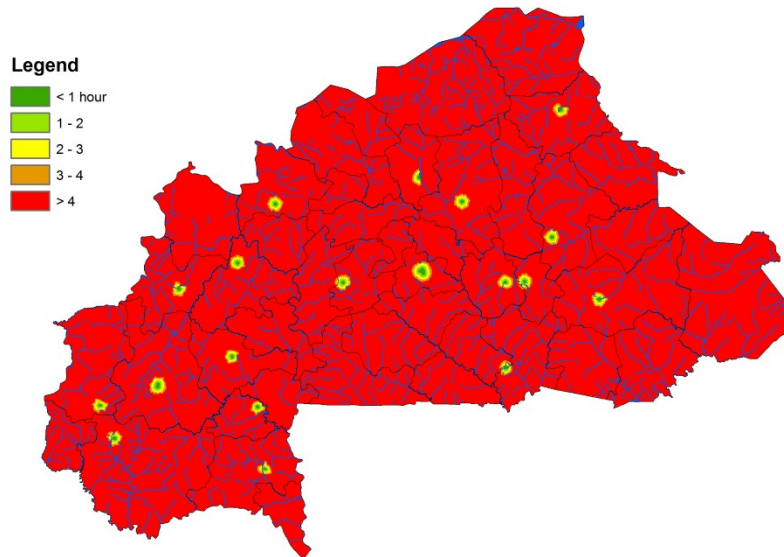
Figure 14 – Travel time to the nearest BEmOC facility considering that pregnant women are walking, or are being carried, until reaching the facility

Using GIS makes it possible to extract the Province and Region level number, and therefore indirectly the percentage of births where the household is located within 2 hours of travel time from a BEmOC facility for both considered scenarios (Annex 11).

Annex 11 confirms the visual observation made here above that when women have no access to motor vehicles but are only able to reach facilities by walking or by being carried, the accessibility coverage at the national level is very low, reaching 11.8 %.

When considering the combined walking/carried – motor vehicle scenario, 61% of women would reach a BEmOC facility within 2 hours of travel time, which indicates that Burkina Faso does not reach universal accessibility coverage to BEmOC facilities at the national level when considering the facilities identified during the 2010 needs assessment (Annex 5).

At the Regional level (Annex 11 and Figure 15), and only considering the combined walking/carried- motor vehicle scenario, we can see the country being separated into three parts:

- Kadiogo as the only Region presenting a coverage above 90%;
- The western and central parts of the country with a coverage varying between 50 and 75%
- The eastern part of the country where coverage is below 50%, reaching as low as 36.1% in the Est Region.
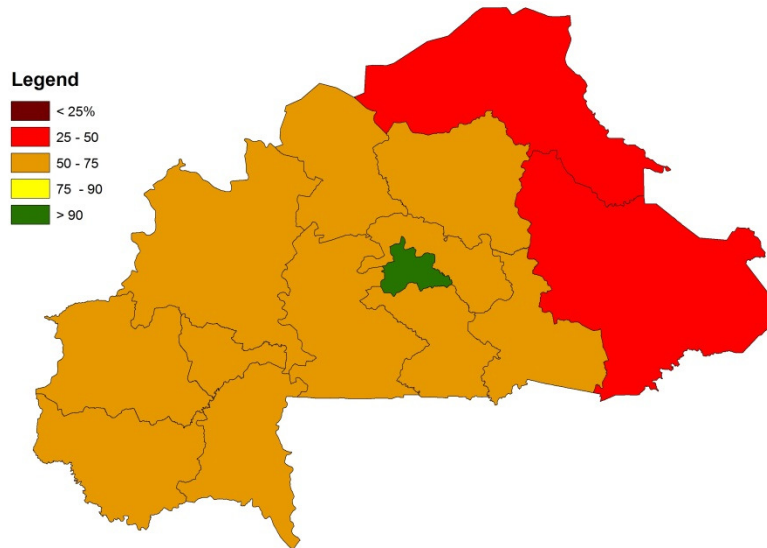
Figure 15 – Region level percentage of births located within 2 hours from a BEmOC, including CEmOC, facilities when considering the combined walking/carried-motor vehicle scenario

At the Province level (Figure 16), the heterogeneity in terms of coverage is significant and pockets of low coverage that were masked at the Regional level are now appearing.

The Provinces presenting the lowest values remains nevertheless located within the Sahel (Yagha) and Est (Kompienga, Tapoa) Regions where coverage is below 25%.
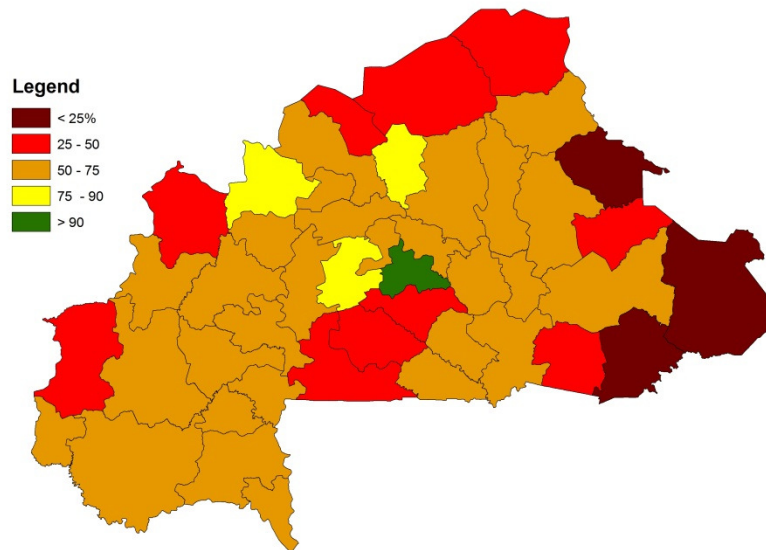
Figure 16 – Province level percentage of births located within 2 hours from a BEmOC, including CEmOC, facilities when considering the combined walking/carried-motor vehicle scenario

The second module of AccessMod has been used to identify the travel time between each BEmOC, including CEmOC, facility and the nearest CEmOC facility. The result of this analysis is reported in Annex 12. In this Annex facilities are listed by Province along with the travel time to the nearest CEmOC facility.

Most of the BEmOC facilites identified during the 2010 needs assessment [17] being actually CEmOC facilites the travel time reported for them in Annex 12 is therefore equivalent to 0.

For the other four facilities providing only BEmOC services, we can observe that the travel time is always inferior to two hours but very close to this benchmark when it comes to the CSPS de Zonse (113 minutes).

In view of the above, the Burkina Faso health system complies with the condition set to define universal accessibility coverage in the context of this project when it comes to the maximum acceptable transfer time between each BEmOC and CEmOC facilities.

This being said, it is important to underline once more that the public health system does not comply to universal accessibility when it comes to reaching BEmOC facilities (Annex 11) and to emphasize that the results obtained for the travel time between BEmOC and CEmOC facilities are conditional to the presence of a functioning motor vehicle on site of each BEmOC facility at the moment of the referral. The transfer time would be higher would such a motor vehicle not be available at the time of the referral.

Finally, Annex 13 provides Province level information and basic statistics, namely:
-    The number of BEmOC, including CEmOC, facilities,

- The number of CEmOC facilities,
- The indication of the BEmOC, including CEmOC, facility being the closest to the Province (identified visually based on the travel time distribution grid reported in Figure 13);
- The min, max and birth weighted mean travel time, expressed in hours, to the nearest BEmOC facility from within each District. The birth weighted mean travel time has been obtained by multiplying the spatial distribution of births (Figure 12) with combined scenario travel time distribution grid (Figure 13) before summarising the value at the Province level (Figure 3) and dividing the results by the corresponding District level total number of births (Annex 4). For reference, the national level birth weighted mean travel time is of 2.31 hours.

Annex 13 allows for example to see that women living in the Province of Nahouri (Centre-Sud Region):
- have to travel between 0.5 and 20 hours before reaching a BEmOC facility as there are currently no BEmOC facilities available in this Province. The birth weighted mean travel time for this Province is of 2.6 hours;
- would most probably go to EmOC facility nbr B1, CSPS de Zonse, if needed based on the accessibility analysis.
- once arrived at the CSPS de Zonse, would then need to travel another 113.8 minutes (Annex 12) in case they would need to be transferred to a CEmOC facility because of complications during delivery. In this case, the closest CEmOC facility would be the CMA de Zorgho (Annex 12).

As such, and based on this analysis only, this Province could be among those for which further analyzes could be conducted and actions taken to improve accessibility to EmOC.

7.2 Geographic coverage analyzes

This second set of analyzes look at including the availability of human resources and equipment into the accessibility coverage analysis conducted in the previous section.

The geographic coverage of the existing BEmOC (including CEmOC) facilities has been measured based on the same layers and data than those used for the accessibility coverage analysis (see section 7.1). The only element that has been added is the maximum coverage capacity of each BEmOC facility to account for the availability of services.

The maximum coverage capacity for each facility, expressed in terms of number of assisted deliveries covered in a year by a facility, has been obtained by multiplying the total number of skilled birth attendant (Annex 5) in each facility with the maximum acceptable workload norms reported in section 6.3.

When we compare the obtained maximum coverage capacity obtained through this multiplication with the 2012 number of assisted deliveries available for 24 facilities we can observe that (Table 7):

- The estimated maximum coverage capacity obtained is systematically above (up to 1220% difference) the number of assisted births for the University (CHU) and Regional (CHR) hospitals;
- The same observation can be made for the Medical centers with surgical antenna (CMA) even if the difference is a little bit lower;
- Except for the Centre Médical Saint Camille, the difference between the two figures is much lower than what is observed for the Health and social promotion centers (CSPS) and Private medical centers (CM).

In conclusion, the approach used in our analysis is most probably overestimating the maximum coverage capacity for the different health facility types. This could potentially be explained by one of the following reasons:

- Not all skilled attendants are necessarily practicing deliveries. This could be the case in particular for CHR and CHU facilities;
- The coverage capacity of several of these facilities is under used;
- The maximum acceptable workload norms which have been defined in Section 6.3 are not appropriate.

Unfortunately, the information at disposal did not allow for verifying which one of the above mentioned reasons could applying here.

EmOC code	Fiche number	EmOC type	Facility name	Facility type	Number of skilled birth attendants (2010)	Maximum acceptabel workload	Maximum coverage capacity	Number of assisted deliveries (MOH, 2012)	Percentage difference between the number of assisted deliveries and the estimated maximum coverage capacity
B1	1710	BEmOC	CSPS de Zonse	CSPS	3	75	225	553	-59.31%
B4	2802	BEmOC	CSPS de Piela	CSPS	9	75	675	2,053	-67.12%
B2	5706	BEmOC	CM de Pouytenga	CM	45	75	3375	2,909	16.02%
B3	439	BEmOC	Centre médical Saint Camille	CM	63	75	4725	1,922	145.84%
C1	4123	CEmOC	CMA de Do	CMA	63	100	6300	4,553	38.37%
C2	4215	CEmOC	CMA de Hounde	CMA	46	100	4600	1,728	166.20%
C3	4026	CEmOC	Clinique Lorentia	CMA	5	100	500	384	30.21%
C5	3733	CEmOC	CMA de Tougan	CMA	45	100	4500	415	984.34%
C6	4623	CEmOC	CMA de Diebougou	CMA	45	100	4500	445	911.24%
C9	4007	CEmOC	CMA de Orodara	CMA	28	100	2800	309	806.15%
C10	720	CEmOC	Clinique Kone Moussa	CMA	19	100	1900	NA	NA
C11	417	CEmOC	CMA du secteur 30	CMA	99	100	9900	2,438	306.07%
C12	1225	CEmOC	CMA de Kongoussi	CMA	58	100	5800	1,131	412.82%
C15	3627	CEmOC	CMA de Solenzo	CMA	53	100	5300	365	1352.05%
C16	24	CEmOC	CMA du secteur 26	CMA	42	100	4200	2,753	52.56%
C17	2328	CEmOC	CMA de Zorgho	CMA	43	100	4300	253	1599.60%
C4	6402	CEmOC	CHU Yalgado Ouedraogo	CHU	250	175	43750	6,201	605.53%
C18	4420	CEmOC	CHU Souro Sanou	CHU	274	175	47950	4,388	992.75%
C7	3222	CEmOC	CHR Dori	CHR	67	175	11725	888	1220.38%
C8	4713	CEmOC	CHR de Gaoua	CHR	35	175	6125	666	819.67%
C13	3807	CEmOC	CHR de Dedougou	CHR	62	175	10850	1,080	904.63%
C14	1628	CEmOC	CHR de Koudougou	CHR	114	175	19950	1,976	909.62%
C19	2931	CEmOC	CHR de Fada	CHR	100	175	17500	1,428	1125.49%
C20	3436	CEmOC	CHR de Banfora	CHR	96	175	16800	1,650	918.18%
C21	1135	CEmOC	CHR de Kaya	CHR	86	175	15050	1,603	838.86%
			Total		1,750		253,300	42,091	

Table 7 – Comparison between the estimated maximum coverage capacity obtained by multiplying the maximum acceptable workload norm by the number of skilled birth attendants in each facility with the 2012 number of assisted deliveries for the BEmOC, including CEmOC, facilities when this information is available

In view of the above, it has been decided to consider that the maximum acceptable workload norms reported in Section 6.3 were appropriate and to then estimate a mean

maximum coverage capacity for the different health facility type based on the 2012 number of assisted deliveries.

In order to expand the sample size when performing this estimation, the partially functional BEmOC and CEmOC facilities considered in the scaling up analysis (Section 7.4) for which a number of assisted deliveries was reported in 2012 have been added to the fully functional BEmOC, including CEmOC, facilities reported in Annex 6 resulting in a total sample of 91 facilities.

Table 8 present the minimum, maximum and average number of assisted deliveries by health facility type among this sample of 91 facilities, differentiating between BEmOC and CEmOC facilities, as well as the corresponding number of skilled birth attendants when using the maximum acceptable workload norms defined in Section 6.3[19].

When considering the average number of assisted deliveries as the maximum coverage capacity of each facility (Table 9), the gap between the estimated coverage capacity of each facility and the corresponding total number of skilled attended births in 2011 is smaller than with the previous approach but the number of facilities for which the estimate is below the actual number of assisted births for 2012 is increasing meaning that, for several facilities, the approach is underestimating the potential number of births that the facility has already been able to cover in 2012.

	Number of facilities in the sample	Minimum number of assisted deliveries	Maximum number of assisted deliveries	Average number of assisted deliveries	Corresponding number of skilled birth atttendants using the norms from Section 6.3
CHR (CEmOC)	9	666	1976	1369	8
CHU (CEmOC)	2	4388	6201	5295	30
CMA (BEmOC)	3	189	371	285	3
CMA (CEmOC)	40	253	4632	1059	11
CM (BEmOC)	3	696	2909	1842	25
CSPS (BEmOC)	34	123	2053	636	8

Total	91

Table 8 – Estimated minimum, maximum and average number of skilled attended births and corresponding number of skilled birth attendants by health facility type

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[19] The corresponding number of skilled birth attendants for the CHR (CEmOC) is for example obtained through the following formula: 1369/175 = 7.8, rounded to 8.

EmOC code	Fiche number	EmOC type	Facility name	Facility type	Maximum coverage capacity	Number of assisted deliveries (MOH, 2012)	Percentage difference between the number of assisted deliveries and the estimated maximum coverage capacity
C7	3222	CEmOC	CHR Dori	CHR	1369	888	54.17%
C8	4713	CEmOC	CHR de Gaoua	CHR	1369	666	105.56%
C13	3807	CEmOC	CHR de Dedougou	CHR	1369	1,080	26.76%
C14	1628	CEmOC	CHR de Koudougou	CHR	1369	1,976	-30.72%
C19	2931	CEmOC	CHR de Fada	CHR	1369	1,428	-4.13%
C20	3436	CEmOC	CHR de Banfora	CHR	1369	1,650	-17.03%
C21	1135	CEmOC	CHR de Kaya	CHR	1369	1,603	-14.60%
C4	6402	CEmOC	CHU Yalgado Ouedraogo	CHU	5295	6,201	-14.61%
C18	4420	CEmOC	CHU Souro Sanou	CHU	5295	4,388	20.67%
B2	5706	BEmOC	CM de Pouytenga	CM	1842	2,909	-36.68%
B3	439	BEmOC	Centre médical Saint Camille	CM	1842	1,922	-4.16%
C1	4123	CEmOC	CMA de Do	CMA	1059	4,553	-76.74%
C2	4215	CEmOC	CMA de Hounde	CMA	1059	1,728	-38.72%
C3	4026	CEmOC	Clinique Lorentia	CMA	1059	384	175.78%
C5	3733	CEmOC	CMA de Tougan	CMA	1059	415	155.18%
C6	4623	CEmOC	CMA de Diebougou	CMA	1059	445	137.98%
C9	4007	CEmOC	CMA de Orodara	CMA	1059	309	242.72%
C10	720	CEmOC	Clinique Kone Moussa	CMA	1059	NA	NA
C11	417	CEmOC	CMA du secteur 30	CMA	1059	2,438	-56.56%
C12	1225	CEmOC	CMA de Kongoussi	CMA	1059	1,131	-6.37%
C15	3627	CEmOC	CMA de Solenzo	CMA	1059	365	190.14%
C16	24	CEmOC	CMA du secteur 26	CMA	1059	2,753	-61.53%
C17	2328	CEmOC	CMA de Zorgho	CMA	1059	253	318.58%
B1	1710	BEmOC	CSPS de Zonse	CSPS	636	553	15.01%
B4	2802	BEmOC	CSPS de Piela	CSPS	636	2,053	-69.02%

			Total		37,837	42,091	

Table 9 - Comparison between the estimated maximum coverage capacity obtained from Table 8 with the 2012 number of assisted deliveries for the BEmOC, including CEmOC, facilities where this information was available

To correct for this, it was decided to finally use the following approach:
- When the estimated maximum coverage capacity from Table 8 was bigger than the number of assisted deliveries observed in 2012, then the estimated maximum coverage capacity from Table 8 has been used (assumes that the facility has been so far operating at less than the maximum capacity in terms of deliveries undertaken with available resources);
- When the estimated maximum coverage capacity from Table 8 was smaller than the number of assisted deliveries observed in 2012, then the 2012 number of assisted deliveries has been considered as the maximum coverage capacity for that facility (which assumes that the facility was operating at maximum capacity in terms of deliveries undertaken with available resources).

The resulting estimated maximum coverage capacity for all BEmOC, including CEmOC, facilities considered in this analysis following this approach is reported in Annex 14.

It is important to note here that the theoretical national coverage capacity of all the BEmOC, including the CEmOC, facilities when it comes to normal deliveries reaches 49,796 births which is below the total number of births where the household is located within two hours of these facilities when considering the combined walking/carried – motor vehicle scenario: 427,144 births (Annex 11). As such, we can already observe here

that there is an important shortage in terms of skilled birth attendant to answer the needs for this particular population.

As per the methodology described under section 5.2, the maximum coverage capacity has also been used to define in which order the facilities would be processed in AccesMod. This order is also reported in Annex 14.

Finally, in view of the importance played by the road network on accessibility only the combined walking/carried – motor vehicle travel scenario has been considered in these analyzes.

Once the above data and information uploaded in ArcGIS, the third module of AccessMod has been used to produce:
1. BEmOC facility specific figures regarding the number of births covered by each facility taking both travel time (2 hour maximum) and the maximum coverage capacity into account (Annex 14);
2. The extension of the catchment area associated to each BEmOC facility (Areas in dark green in Figure 17 (zoom) and Figure 19 (full country));
3. Region and Province level number and percentage of birth where the household is located within 2 hours of travel time to a BEmOC (including CEmOC) facility when taking both travel time and coverage capacity into account (geographic coverage (Annex 15). This Annex does also contain the difference, in percents, observed between accessibility and geographic coverage for both administrative levels.

In view of the very low values obtained, the spatial distribution of geographic coverage has not been mapped and this for both the Regional and Province level.
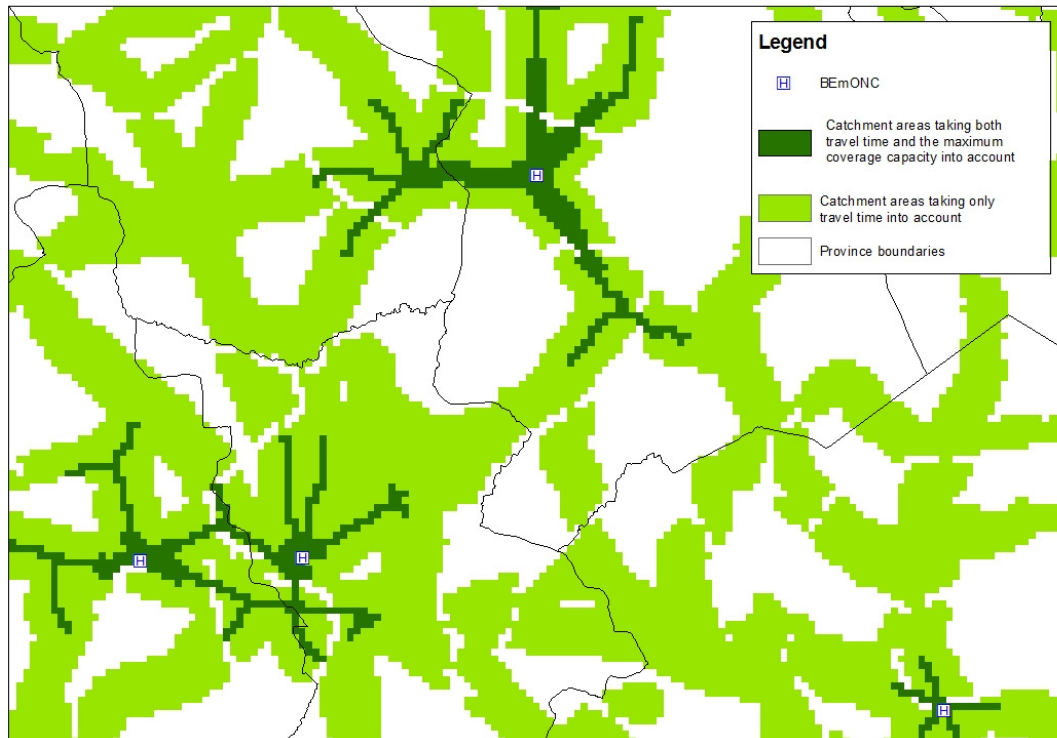
Figure 17 – Example of comparison between the catchments areas obtained through the accessibility coverage analysis (light green) and those from the geographic coverage analysis (dark green)

Then from Annex 14 and 15 as well as Figure 17 and 19 we can observe that:
- The coverage capacity estimated for all the BEmOC facilities has been used in the analysis;
- Taking into account the assumptions considered for this analysis (see Chapter 3), national geographic coverage reaches 7.1%. Burkina Faso does therefore not meet the universal geographic coverage benchmark set for BEmOC. geographic coverage is actually also low at the Regional and Provincial level;
- 49,795 (Annex 15) of the all 427,144 births located within two hours of travel time of a BEmOC facility (Annex 11) can expect to find enough skilled birth attendant to cover the demand in the concerned facilities.
- Several Provinces are presenting a geographic coverage equal to 0, these are (by alphabetical order): Bazega, Komonjdjari, Kompienga, Kossi, Koulpelogo, Kourweogo, Leraba, Loroum, Nahouri, Noumbiel, Oubritenga, Oudalan, Passore, Sanguie, Sissili, Soum, Tapoa, Yagha, Yatenga, Ziro and Zondoma;
- The Regions presenting the highest difference between the accessibility and geographic coverage (Annex 15 and light green areas in Figure19) are:
  - Centre (76.4 % difference)
  - Centre-Nord (67.0%)
  - Plateau Central (60.4%)

- The Provinces presenting a difference higher than 60% are also located in the same three Regions as well as in the Boucle du Mouhoun, Centre-Sud, Centre-Ouest, Nord and Sud-Ouest Regions.

The second part of this analysis looks at estimating the geographic coverage offered by CEmOC for deliveries with complications. As universal accessibility coverage is not reached at the BEmOC level, this analysis is not complete but already serves as an indication of a potential gap in human resource capacity among the CEmOC reported in the 2010 assessment.

The nearest CEmOC facility to each BEmOC facility identified during the accessibility coverage analyzes (Annex 12) has been used to refer these 5% of the normal deliveries (Annex 14) to the corresponding CEmOC facility. The result of this operation is reported in Annex 16.

In both cases, the expected number of EmOC surgical teams has been obtained by dividing the number of births (referred or real) by 60, this being the maximum acceptable workload in terms of number of C-sections per year per EmOC surgical team as defined in Section 6.3.

As we can see from the last two columns on the right in Annex 16:
- There would be enough EmOC surgical teams in 16 CEmOC facilities when considering the number of births referred for complication by the model (negative values). For the remaining 5 facilities, the gap is inferior to 1 team except for the CMA du secteur 26 (2.3 additional teams estimated to be needed);
- There is a gap in terms of number of estimated EmOC surgical teams required in 17 of the 18 CEmOC facilities for which there is data when considering the real number of births delivered by C-sections. The most important gap in this case is observed in the CHU Yalgado Ouedraogo for which an additional 67 teams would be required to cover the demand[20].

Two issues would first need to be addressed before using these results to take any decision aiming at modifying the current number of EmOC surgical teams in these facilities:
1. The real number of operating theaters in each facility should be integrated in this analysis. For the moment, the result of the 2010 needs assessment was more qualitative than quantitative in nature when it comes to this indicator;
2. The maximum acceptable workload of 60 C-section per EmOC surgical team per year might need to be revisited in view of the figures reported in Annex 16. As an indication, in order to be able covering the demand (both the modeled and the real one), this maximum workload would be between 150 and 180 C-sections per year

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[20] this finding suggests that the workload indicator of 60 C-section per EmOC surgical team per year is ineffective since obviously the CHU Yalgado Ouedraogo is performing a much higher number of C-sections without having such resources available.

depending if the CHU of Yalgado Ouedraogo is considered in the estimation or not.

Regarding the second point here above, if the maximum acceptable workload should remain equal to 60 C-sections per EmOC surgical team per year, then it is clear that Facilities such as the CHU of Yalgado Ouedraogo, the CHU of Souro Sanou and the CHU of Koudougou are understaffed to cover the demand.

7.3 Service utilization analyzes

This set of analyzes looks at comparing the results of the accessibility (Section 7.1) and geographic (Section 7.2) coverage analyzes with real data on service utilization to see if there are gaps between the two. The data used to perform these analyzes are therefore the results from the above two mentioned analyzes, sub national level data collected in the context of the 2010 Standard DHS survey [12] and health facility level data provided by the MOH.

For BEmOC facilities, and at the national level, 42,091 births were delivered in BEmOC facilities in 2012 (Annex 6), which corresponds to around 6% of the total births if we consider the estimates generated for 2011 (Annex4). This is not too far off from our estimate of the percentage of births where the household is located within 2 hours of travel time of a BEmOC with sufficient capacity to provide services as per the result of the geographic coverage analysis (Annex 15) – 7.1%. Nevertheless, out of all births, 66.3% were delivered in any facility according to the most recent DHS (Table 3). This provides a first clear indication that a large number of women are delivering in non-certified EmOC facilities.

The second part of the analysis consists in overlapping the cluster level number of unattended home deliveries from the 2010 DHS (Figure 11) on top of the catchment areas obtained through the accessibility and geographic coverage analysis.

When looking at the resulting map (Figure 18) it is important to remember that:
- The sampling frame of DHS surveys is designed to ensure that the final dataset is representative at the national and sub-national level but not at the cluster level;
- The location of each cluster is randomly shifted (see Section 6.2.7) and we do not know the exact size of each cluster.

In view of the above, only qualitative or semi-quantitative observations can be made from the map reported in Figure 18.

Considering the above limitation, Figure 18 shows unattended home deliveries located in areas further away than 2 hours from a BEmOC facilities (around 10% of the 4,339 unattended home deliveries located on the map). For these births, physical accessibility is a main barrier to accessing BEmOC and could explain unattended home deliveries.

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An important percentage of unattended home deliveries (around 76% of them) are then finding themselves within 2 hours of travel time of a BEmOC facility but would not find enough capacity to cover the demand if they were to seek for care in these facilities. In this case, availability of care is the main barrier that could explain unattended home deliveries. This being said, non-EmOC facilities might be located within 2 hours of travel time of the household where these unattended births took place.

Finally, the remaining 14% of the unattended home deliveries considered here are finding themselves within 2 hours of travel time of a BEmOC that would have enough capacity to cover the demand. In this case, neither accessibility nor availability appears to be the reasons for the non-utilization of EmOC services.
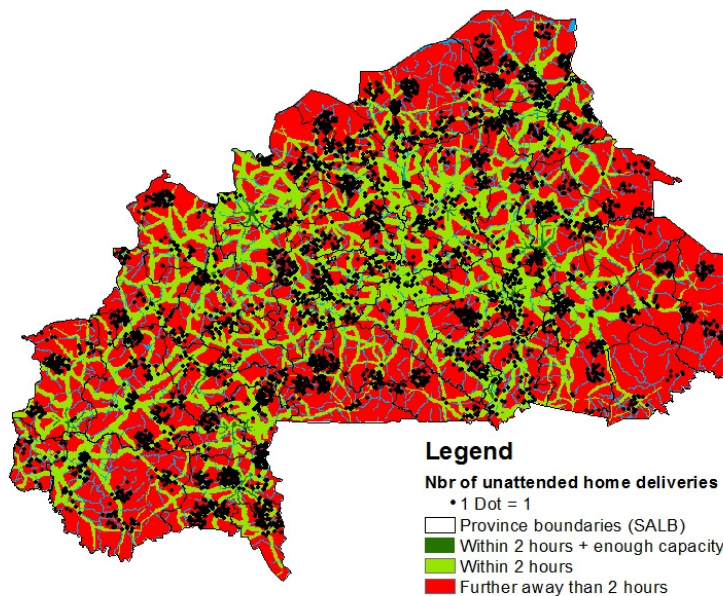
Figure 18- Number of unattended home deliveries (DHS, 2010) on top of the catchment areas from the accessibility and geographic coverage analysis

In complement to Figure 18, the regional level percentage of births covered through the accessibility and geographic coverage analyzes have been put in relation to the percentage of live births in the five years preceding the survey delivered in a health facility, public or private, coming from the 2010 DHS [12] (see Section 6.1.2) (Figure 19).

The following can be observed from Figure 19 taking into account that only public EmOC facilities have been considered when conducting the accessibility and geographic coverage analysis:

- An important variability is observed among Regions when it comes to the percentage of births delivered in a health facility (public or private). Among them, the Regions of Sahel, Sud-Ouest and Est are those presenting the lowest percentage and are therefore those where the highest proportion of unattended home deliveries are to be expected;
- All Regions are presenting an accessibility and geographic coverage below the 90% benchmark (red line in Figure 19) as per the results already presented in sections 7.1 and 7.2. This confirms that both availability and accessibility are barriers to BEmOC services utilization in Burkina Faso;
- The Regions of Sahel, Sud-Ouest, Centre-Ouest and Centre-Nord are presenting an accessibility coverage higher than the percentage of births delivered in a public or private health facility which might be an indication that, in these Regions, the probability for such birth to take place in a BEmOC facility is higher than in the other 5 Regions;
- Geographic coverage is itself systematically much lower than the percentage of births taking place in an health facility which confirms that availability is a much important barrier than accessibility when it comes to BEmOC services.
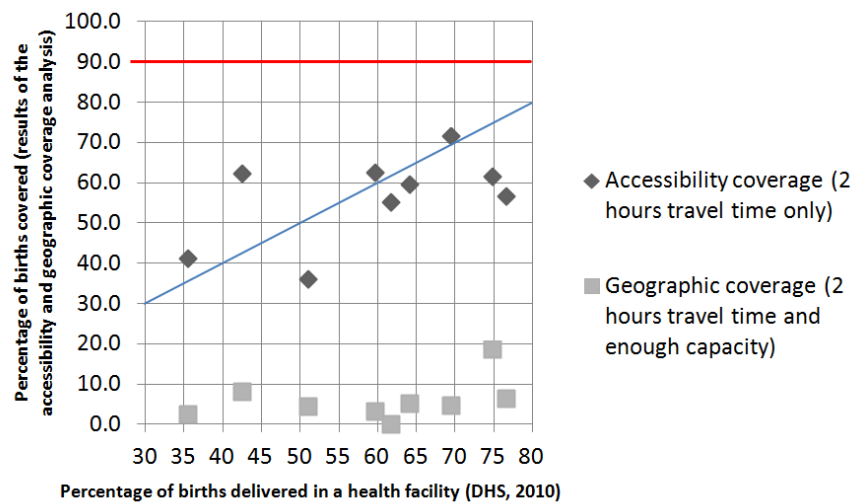
Figure 19 - Region level percentage of births covered by BEmOC facilities as determined through the accessibility and geographic coverage analysis plotted against the percentage of births delivered in a public or private health facility [12][21]

When it comes to CEmOC facilities, the availability of both health facility level data from the MOH as well as sub national level data from the DHS allowed performing both comparisons listed under point 6 in section 5.3.

First, and as the travel time between all the BEmOC and the nearest CEmOC facility is below two hours (Annex 12), the district level percentage of births with complication as

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[21] The region level figures used for creating this graph can be found in Table 3, Annex 11 and Annex 15

referred to a CEmOC facility through the geographic coverage analysis (Annex 15) has been compared to the percentage of births delivered by C-section as per the DHS.

The former has been calculated for each district by taking 5% of the births located within two hours of travel time to a BEmOC (including CEmOC) facility and for which there is enough capacity in the facility (accessibility coverage) and dividing this value by the total number of births in that same district. Doing so allows comparing the results of the model with the DHS data (Table 10).

Region code	Region name	Percentage delivered by C-Section (DHS, 2010)	Percentage of all births that can reach a CEmOC within 2 hours in case of complications
BFA013	Centre	8.2%	1.0%
BFA046	Boucle du Mouhoun	1.6%	0.3%
BFA047	Cascades	1.1%	0.3%
BFA048	Centre-Est	1.2%	0.3%
BFA049	Centre-Nord	0.6%	0.2%
BFA050	Centre-Ouest	1.5%	0.2%
BFA051	Centre-Sud	2.5%	0.0%
BFA052	Est	0.9%	0.2%
BFA053	Hauts Bassins	2.7%	0.9%
BFA054	Nord	1.6%	0.0%
BFA055	Plateau Central	1.8%	0.2%
BFA056	Sahel	0.2%	0.1%
BFA057	Sud-Ouest	0.7%	0.4%
	Nation wide	1.9%	0.4%

Table 10 - Region level comparison between the percent of live births delivered by C-section in the five years preceding the DHS survey in both public and private facilities [12] and the percentage of births referred to the nearest CEmOC facility through the geographic coverage analysis

In Table 10, the fact that the percentage obtained through the model is always lower than the one reported in the DHS can be explained as follow:
- non-EmOC facilities, including facilities from the private sectors, are most probably also referring births with complications to CEmOC facilities;
- An important percentage of C-sections are taking place in the private sector;
- a certain number of C-sections taking place in CemOC facilities are not referred during delivery but planned in advanced
- more than 5% of all birth are actually referred for complications from BEmOC facilities.

The second analysis consists in comparing the number of births with complications to be covered at the CEmOC level according to the model during the geographic coverage analysis (Annex 16) with the real number of C-sections performed in these CEmOC facilities in 2012 (Table 5).

The result of this comparison is reported in Figure 20 and shows a number of births referred by the model being lower than the real number of C-sections reported by the Ministry of Health for 2012 and this for all the considered health facilities therefore confirming the observations made at the regional level.
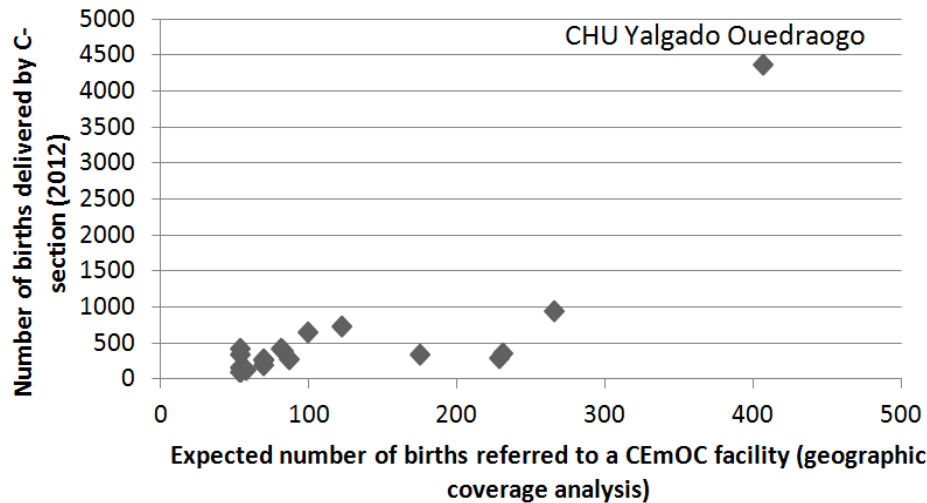
Figure 20 – Comparison between the health facility level expected number of births referred for complication to a CEmOC facility from the geographic coverage analysis with the number of births delivered by C-section in 2012[22]

7.4 Scaling up analyzes

The accessibility coverage analyzes performed to date (Section 7.1) indicates that the BEmOC, including CEmOC, facilities identified during the 2010 EmOC needs assessment [17] are not sufficient to reach universal accessibility coverage nor geographic coverage (Section 7.2).

The same analysis did nevertheless confirm that universal accessibility coverage is reached when it comes to the travel time between each BEmOC facilities and the nearest CEmOC facility in case of referral for complications during delivery.

Unfortunately, the fact that universal accessibility coverage as well as the available CEmOC facility level data regarding EmOC surgical teams did not allow to fully confirming if these facilities were having enough capacity to cover the demand in terms of C-section would 5 % of the birth being delivered in BEmOC facilities have been referred to them.

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[22] The x axis does not take into account the capacity and availability of EmOC surgical teams. The values used corresponds only to 5% of the births handled at the BEmOC level as per the results of the geographic coverage analysis

It is therefore not possible to conclude if the current health system allows for the referral model followed here (Figure 1) to provide universal geographic coverage at the CEmOC facility level. The comparison made with the real number of C-sections performed in 2011 and the estimated number of EmOC surgical teams is already indicating that the capacity at disposal might indeed not be sufficient for that (Annex 16).

In view of the above, the last two modules of AccessMod have been used to look at potential scenarios aiming at scaling up the BEmOC network identified during the 2010 EmOC assessment in order to reach universal geographic coverage and analyze the impact this would have at the CEmOC level.

In the case of Burkina Faso, extending the coverage capacity of the 25 BEmOC, including CEmOC, facilities identified during the 2010 EmOC needs assessment [17] to cover all births where the household is located within 2 hours of travel time of these facilities, as per the results of the accessibility analysis (Annex 11), would not be sufficient as geographic coverage would then only reach 61%.

Additional BEmOC facilities therefore need to be added to those identified as fully EmOC in 2010.

First scale-up scenario

The first scale-up scenario entails expanding the number of BEmOC facilities, and applying the assumptions for maximum coverage capacity.

In the first part the estimated maximum coverage capacity is applied and the travel time to access the facility is set to 2 hours.

For this analysis we considered the facilities for which a coordinate (Latitude/longitude) was available and when the facility was identified as:
- partially CEmOC when performing at least 6 of the 9 CEmOC signal functions including blood transfusion and C-section (an additional 40 facilities);
- partially BEmOC when performing at least 6 of the 7 BEmOC signal functions (an additional 40 facilities as well).

The final list (Annex 17 and Figure 21) therefore includes 105 facilities when including the 25 facilities identified as fully BEmOC or CEmOC during the 2010 needs assessment (Annex 14).

The maximum coverage capacity for these new 80 facilities has been estimated using the same approach than the one described in Section 7.2, meaning that
- When the estimated maximum coverage capacity from Table 8 was bigger than the number of assisted deliveries observed in 2012, then the estimated maximum coverage capacity from Table 8 has been used;
- When the estimated maximum coverage capacity from Table 8 was smaller than the number of assisted deliveries observed in 2012, then the 2012 number of

assisted deliveries has been considered as the maximum coverage capacity for that facility.

When the number of assisted deliveries was missing, the estimated maximum coverage capacity from Table 8 has been used. Please also note that polyclinics and clinics have been considered as medical centres with surgical antenna (CMA).
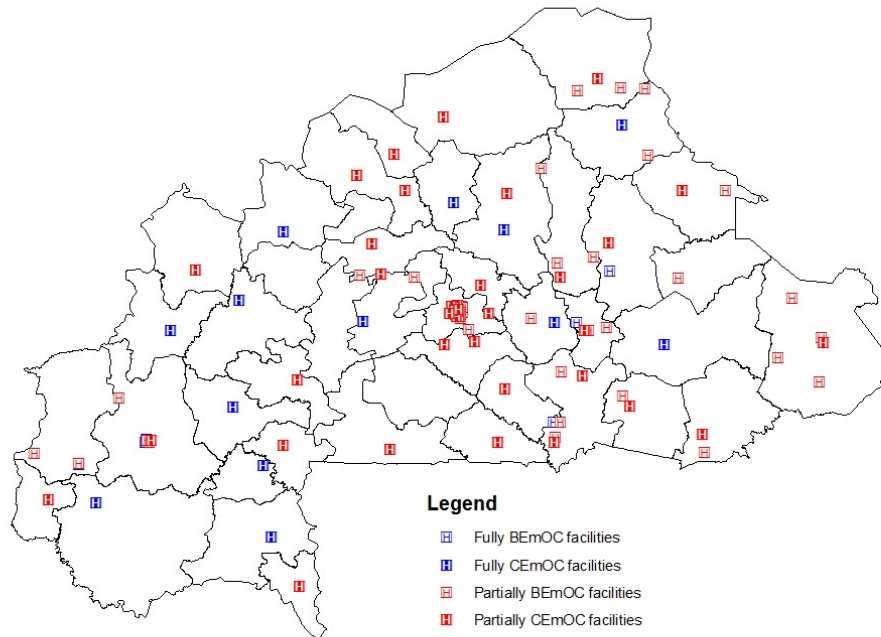
Figure 21 - Location of the fully and partially BEmOC and CEmOC facilities considered in the scaling up scenario

Doing so, the total maximum coverage capacity for the 105 considered facilities reaches 134,134 births (Annex 17) which corresponds to only 19.1% of all births estimated as taking place in the country in 2011 (Annex 11). So, while the percentage would increase from 7.1% to 19.1%, this approach would therefore also not allow reaching universal geographic coverage.

In the second part of the analysis for the first scale-up scenario the maximum travel time remains constrained to 2 hours but the coverage capacity of the 105 facilities reported in Annex 17 is extended in order to cover all births where the household is located within these 2 hours of travel time.

This scenario uses the same data as those used for the geographic coverage analysis (Section 7.2) and the third module of AccessMod, with the only exceptions that, in this case:
- the coverage capacity of each BEmOC, including CEmOC, facility has been set to be unlimited. Doing so allows for ensuring that all births where the household is

located within 2 hours of travel time of each facility are attached to these facilities in the simulation;
- the processing order has been defined as follow (resulting order reported in Annex 17):
    - Fully EmOC facilities before the partial ones;
    - Decreasing order for the number of BEmOC signal functions. Doing so allows prioritizing the facilities for which fewer resources would be needed for the upgrade;
    - Decreasing order for the maximum coverage capacity in order to consider first those facilities that have the potential to cover a higher number of births

In view of the importance played by the road network on accessibility only the combined walking/carried – motor vehicle travel scenario has been considered in these analyzes.

The BEmOC, including CEmOC, facility level results when applying this scenario are then presented in Annex 18.

In Annex 18:
- The equivalent number of skilled birth attendants needed to cover the demand has been obtained by dividing the number of assisted deliveries in 2012 by the maximum workload considered for each type of facilities as reported in Section 6.3;
- The gap in skilled birth attendant for each facility has been obtained by subtracting the number of skilled birth attendants identified during the 2010 needs assessment from the equivalent number of skilled birth attendants needed to cover the demand.

Implementing this scenario allows for the BEmOC, including CEmOC, facilities listed in Annex 17 to cover 484,218 births where the household is located within 2 hours of travel time, corresponding to a geographic coverage of 69.2% at the national level. We therefore remain largely below the universal geographic coverage benchmark and would only gain 8.1% coverage compare to extending the coverage capacity of the 25 fully EmOC facilities to cover all the births where the household is located within 2 hours of travel time.

In addition, the analysis indicates that implementing this scenario would require an additional 2,429 SBAs in 21 health facilities that are estimated to not have sufficient capacity to respond to the demand (sum of the values in white color cells in the last column on the right, Annex 18). On the other hand, 82 facilities are estimated to have a surplus of SBAs. The relocation of some of the 2,327 skilled birth attendants which are recorded as a surplus in Annex 18 (blue color cells in the last column on the right) could be part of the strategy to fill this gap, but at the minimum the hiring of an additional 102 skilled birth attendants will be required.

This would not only result in an important cost but also in the need for additional working space and equipment in some facilities such as the CHU Yagaldo Ouedraogo or the CM de Pouytenga for which the model predicts respectively the need for an additional 616 and 590 skilled birth attendants. This scenario indicates that the distribution of human resources is obviously not well located from the perspective of travel time. The estimated patient overload at some facilities could actually be distributed among other BE,OC facilities located near the households.

As discussed above, expanding the coverage capacity at the existing 25 facilities to cover all births within 2 hours travel time would result in 61% geographic coverage. The first scale-up scenario with 105 facilities results in a geographic coverage of 69.2%. The main reason for the limited gain in terms of geographic coverage when expanding from 25 to 105 facilities is mainly explained by the large spread of births outside of the major cities as per the births distribution grid used in this analysis (Figure 12).

This distribution being the result of a model, and of the data available to the Landscan project [23], it can very much be that this model tends to overestimate the spread of the population in rural areas in Burkina Faso, thereby leading to the results obtained here. This being said, 80% of the population lives in rural areas in Burkina Faso and the population distribution grids generated in the context of other projects such as GPW [24] or WorldPop [25] are also presenting a similar spread in rural areas.

If this spread is confirmed, then the application of the scenario presented here would be a confirmation that upgrading all the partially functioning BEmOC facilities in the country would not necessarily result in a significant gain in terms of geographic coverage according to the benchmark set in the context of this project. Other solutions, such as the establishment of waiting homes near the already fully BEmOC facilities, and allowing for all pregnant woman living further away than 2 hours of travel time from a BEmOC facility to access these waiting homes might therefore represent a more cost-effective solution.

This new alternative has been tested in the context of the second scenario presented here below.

Second scale-up scenario

The second scale-up scenario considers the use of maternity waiting homes. Maternity waiting homes are residential facilities, located near a qualified medical facility, where women defined as "high risk" can await their delivery and be transferred to a nearby medical facility shortly before delivery, or earlier should complications arise [27].

In this particular case, it has also been considered that women living further away than 2 hours of travel time, and therefore not necessarily at "high risk" would also be given access to these waiting homes and that one waiting home would be located near each of

the existing 25 BemOC, including CEmOC, facilities identified during the 2010 needs assessment (Annex 5).

When it comes to the maximum travel time considered in the analysis, tests have been performed using the travelling time grid generated during the accessibility coverage analysis (see Section 7.1) to see after how many hours of travel time from these waiting homes we would be reaching the 90% benchmark in terms of accessibility coverage. In the case of Burkina Faso, we found that geographic coverage would reach over 90% with the 25 existing EmOC facilities if all pregnant women living between 2 and 6 hours of travel time came to the waiting homes and resources made available to ensure their stay.

In reality, the national policy would not restrict access to maternity waiting homes based on travel time. Moreover, in many settings, the waiting homes may be primarily meant for women at high obstetric risk, and not for all pregnant women. The criteria for high risk pregnancies must be defined locally and will depend on the available resources and local risk factors [27]. For the purpose of the analysis presented here however, we have not considered the proportion at risk since the general assumption is that 90% of women should have access to EmOC.

This analysis has been conducted in two steps, namely:
1. The maximum coverage capacity of the existing BEmOC, including CEmOC, facilities has been extended to cover all the births where the household is located within 2 hours of travel time;
2. The spatial distribution of the births not covered by the existing BEmOC facilities during step 1 has then been used as input data to attribute the births where the household is located between 2 and 6 hours of travel time to one of the 25 waiting homes to be established.

Two variants can be considered when attributing the births where the household is located between 2 and 6 hours of travel time to one of the waiting homes, namely:
2a. It is considered that the health system is well established and is able to identify to which waiting home each pregnant women should be sent based on the available capacity in each BemOC;
2b. Pregnant women are being sent to the nearest waiting home, in terms of travel time, from their respective household.

Both variants have been tested here as they do have different implications in terms of cost, both on the patient and health service delivery side.

First variant

When considering the first variant (2a here above), the processing order followed in both steps of the analysis is the same as the one followed during the geographic coverage analysis (Annex 14), meaning that priority will be given to facilities having the highest coverage capacity.

The BEmOC, including CEmOC, facility level results when applying this scenario are then presented in Annex 19.

In Annex 19, the number of skilled birth attendants needed to cover the demand as well as the gap in skilled birth attendant for each facility have been calculated in the same way than for Annex 18.

Implementing this first variant of the second scenario allows for the 25 BEmOC, including CEmOC, facilities identified during the 2010 needs assessment [17] to cover 649,814 births (of which 427,144 births are those where the household is located within 2 hours of travel time and an additional 222,670 births would be women that would travel from further away before the due date and stay in waiting homes). This corresponds to a geographic coverage of 92.9% at the national level. This scenario would therefore reach the universal geographic (90%) coverage benchmark for BEmOC facilities.

This being said, implementing this scenario would require the construction and maintenance of waiting homes and associated facilities. As shown in Annex 19, 13 facilities would have a total gap of 3,203 skilled birth attendants (sum of the white color cells in the last column on the right, Annex 19). On the other hand, the remaining 12 facilities indicate a potential SBA surplus totaling 480 (sum of the blue color cells in the last column on the right, Annex 19). Some of the gap may therefore potentially be filled through relocation of some of these 480 skilled birth attendants. At the minimum however, the hiring of an additional 2,723 skilled birth attendants will be required.

The issue of cost as well as working space and equipment problems in some facilities would remain (case of the CHU Yalgado Ouedraogo or CM de Pouytenga for example) as the number of births to be covered would be very high in this case.

We can also observe that the number of births covered by the Clinique Kone Moussa as well as the Clinique Lorentia would be very low in this scenario and this because their load is being covered by other EmOC facilities located just next to them: the CHU Yalgado Ouedraogo, the Saint Camille medical center, the CMA from sectors 30 and 26 in the case of the former and the CHU Souro Sanou as well as the CMA de Do in the case of the later.

The travel time between each BEmOC facility and the nearest CEmOC facility would remain the same than for the geographic coverage analysis (Annex 12) but the expected

number of births to be referred to these same CEmOC facilities would increase as reported in Annex 20. In this case, the gap in terms of EmOC surgical teams is important. If one considers the estimated number of births and the benchmark for 60 C-sections per surgical team as defined in Section 6.3, the analysis indicates a gap of 488.5 teams in total if resources could be redistributed between facilities, and a gap of 498 teams if redistribution would not be possible in the short term.

Implementing this scenario would therefore also require hiring, or transferring EmOC surgical teams from other facilities not yet complying with CEmOC.

When looking at the geographic coverage obtained with this scenario at the Region and Province level (Annex 21) we can see that nine of the thirteen Regions are above the 90% benchmark and the others are close to this benchmark except for the Est Region (81.9%). At the Province level, eleven Provinces would have coverage below 90%, the Province of Yagha in the Sahel Region presenting the lowest figure with 77.7%.

Second variant

For the second variant (2b here above), the same approach than for the first variant has been applied when it comes to the births where the household is located within 2 hours of travel time of a BEmOC, including CemOC facility. The results for this particular part of the population remains therefore the same in Annex 22.

When it comes to the attribution of the births located between 2 and 6 hours of travel time to a waiting home, the travel time distribution grid generated during the accessibility analysis for the combined walking/carried and vehicle scenario (Figure 13) has been used to identify which waiting home is the nearest in terms of travel time for any given location in the country.

This is done by using the Path Distance Allocation tool in ArcGIS. The result is itself presented in Figure 22.
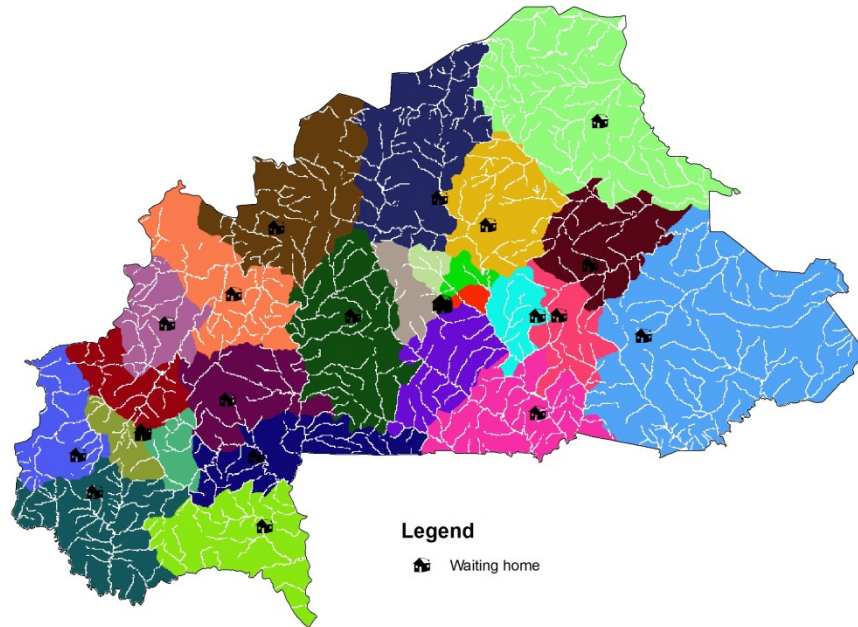
Figure 22 - Extension of the nearest travel time catchment area for each waiting home

Using the grid reported in Figure 22, it is then possible to attribute the births located between 2 and 6 hours of travel time to the nearest waiting home. The result of this operation is reported in Annex 22 at the same time than the corresponding number of skilled birth attendants needed to cover the demand and the gap in skilled birth attendants.

Implementing this second variant of the second scenario allows to cover the same number of births than for the first variant, 649,814 births as well as the same geographic coverage at the national level, 92.9%.

The impact on the number of skilled birth attendants is nevertheless different, as this second variant indicates a gap of skilled birth attendants in 20 out of the 24 facilities, totaling 3,190 (cells in white in the last column on the right in Annex 22). Filling this gap would require the redistribution or employment of additional skilled birth attendants, among which a potential strategy could be redistribution of the 109 SBAs currently in facilities that are estimated to have a surplus over the 90% target (the sum of the blue color cells in the last column on the right, Annex 22). At the minimum however, the hiring of an additional 3,081 skilled birth attendants will be required.

The reason for this difference in health worker requirements compare to the first variant is mainly due to the fact that the maximum workload benchmark set in the context of this project differs according to the type of health facility (See Section 6.3). By attributing births to the nearest waiting home, and therefore directly to the nearest BEmOC facility, more births are attached to facilities in which skilled birth attendants are spending time

on other activities than giving birth, therefore requiring a higher number of them to cover the demand.

This difference in redistribution of the births among BEmOC facilities results in a different distribution of the referred births with complications among CEmOC facilities but not in an increase in terms of EmOC surgical team as, in this case, the maximum acceptable workload is the same for any health facility type (Annex 23).

The Regional and Province level distribution of geographic coverage remains also the same as both variants are actually covering the same births. The figures reported in Annex 21 do therefore also apply to this variant.

Policy implications of the above scale up scenarios

The above two scenarios indicate that upgrading all partially functional EmOC facilities in the country would not significantly increase geographic coverage due to the large spread of the population in rural areas and that looking for alternative solutions such as the establishment of waiting homes near already existing EmOC facilities could have a much important impact on geographic coverage.

Table 11 below summarizes the three scale-up scenarios modelled. In terms of the maternity waiting home (MWH) scenarios, one could for example take the modelling further and assume that women living within 2-6 hours of distance would be referred to a MWH based on the existing capacity (as per scenario 2 variant 1 below), whereas women living further away than 6 hours could be referred simply to the nearest waiting home, to minimize the travel time for them and their families.

We have not modeled the outcomes for the population living more than 6 hours away in the scenarios presented here, since the results here are mainly for illustration, to indicate the resources needed to reach a 90% geographic coverage target. The overall purpose is to indicate the kind of analysis and results that can be done for a scale-up analysis, and that the Burkina Faso Ministry of Health may wish to consider for national purposes related to maternal health planning.

Scenario	Action	Result	Cost implications	Policy issues and modelling issues raised
Scenario 1	Upgrading the functionality of the EmOC facility network from 25 to 105 fully functional facilities	Geographic coverage of 69.2%; this would require filling a human resource gap of 2,429 SBAs in 21 facilities. This would entail the recruitment of a minimum 102 SBAs (with potential further recruitment and/or relocation of an additional 2,327 SBAs)	Facility upgrades; recruitment; relocation	Whether all EmOC functions are required in all facilities; SBA norms
Scenario 2 v1.	Constructing maternity waiting homes, women attributed based on available capacity (within 6 hours).	Geographic coverage of 92.9%; this would require filling a human resource gap of 3,203 SBAs in 13 facilities. This would entail the recruitment of a minimum 2,723 SBAs (with potential further recruitment and/or relocation of an additional 480 SBAs)	MWH Construction, staffing and maintenance costs; recruitment; relocation	Referral/attribution of pregnant women to waiting homes; SBA norms
Scenario 2 v2.	Constructing maternity waiting homes, women attributed based shortest travel time (within 6 hours).	Geographic coverage of 92.9%; this would require filling a human resource gap of 3,190 SBAs in 20 facilities. This would entail the recruitment of a minimum 3,081 SBAs (with potential further recruitment and/or relocation of an additional 109 SBAs)	MWH Construction, staffing and maintenance costs; recruitment; relocation	Referral/attribution of pregnant women to waiting homes; SBA norms

Table 11 - Summary of scale-up scenarios presented above (with MWH: Maternity Waiting Home; SBA: Skilled birth Attendant)

It should be noted that the following will have to be addressed before using the results of the second scenario to do any cost analysis:

1. Several of the input parameters, such as the maximum acceptable workload for skilled birth attendants and EmOC surgical teams, will require further discussion and validation;
2. The health facility level data would have to be completed, in particular the real number of assisted births and number of C-sections;
3. The list of facilities considered in the scenario would require further discussion and agreement in order to account for the fact that the coverage capacity of some facilities has not been used and that geographic coverage is estimated to be below the 90% benchmark for two Provinces is;
4. Assumptions regarding the modelling of policies related to maternity waiting homes would need to be discussed, and the population in need identified, whether this include a subpopulation of women identified as high risk. Furthermore, the approach to be used within the modelling to attribute women to maternity waiting homes would require further discussion, i.e., whether this would entail a specific referral system which would be based on EmOC facility characteristics or be based on the shortest travel time.

8. Conclusions and recommendations

The results obtained in the context of this project have the objective to inform policy discussions on how to optimize, or target, the spending of the marginal dollar for maternal health in countries.

The analysis of the accessibility and geographic coverage of the currently existing network of EmOC facilities on the basis of the referral model presented in Figure 1 was carried out to see if:
- 90% of all births would be within 2 hours of travel from a BEmOC facility and there would be enough capacity in these facilities to answer the demand;
- Deliveries with complications requiring C-section and/or blood transfusion (estimated as 5%) taking place in a BEmOC facility could be transferred to the nearest CEmOC facility in less than 2 hours and the capacity in these facilities would be sufficient to cover the demand.

In the case of Burkina Faso, considering the above mentioned model and taking into account the data limitations described in Chapter 6 (mainly time discrepancies between datasets and exclusion of EmOC facilities that are not reporting to the Ministry of Health), the analyses performed in the context of this project demonstrated that:
- From an accessibility coverage perspective (see Section 7.1), the EmOC delivery network identified during the 2010 needs assessment [17] allows for 61% of all births to reach a BEmOC facility in less than 2 hours. Universal accessibility coverage is therefore not reached for BEmOC facilities.
- There is a CEmOC facility within 2 hours of each BEmOC facility, indicating that the health system in Burkina Faso would comply with the condition set to define

universal accessibility coverage as per the current framework but this remains conditional on the presence of a functioning motor vehicle on site of each BEmOC facility at the moment of the referral;

- When looking at geographic coverage (Section 7.2):
    o The coverage offered by the existing network of BEmOC facilities is very low, 7.1% at the national level (Annex 15), the health system therefore not complying with the definition set for universal geographic coverage;
    o For CEmOC facilities, discrepancies among the different sources of health facility level data regarding the number of EmOC surgical teams did not allow for assessing if the capacity in each facility would be sufficient to cover the demand would 5% of all births taking place in BEmOC facilities be referred to CEmOC facilities.

Comparing these results with the first and second indicator of the 2009 WHO, UNFPA, UNICEF and Malman School of Public Health handbook for monitoring emergency obstetric care (Annex 2 [2]) as well as the density of EmOC facilities (BEmOC including CEmOC facilities) and CEmOC facilities at the Province level (Table 2) we can note that, in the case of Burkina Faso:

- When it comes to BEmOC, including CEmOC, facilities:
    o 25 facilities for a total population of 16,968,000 [10] corresponds to a national ratio of 0.74 BEmOC facilities per 500,000 inhabitants. This is far below the benchmark level set in the 2009 handbook [2] when it comes to the availability of EMOC facilities (indicator 1 in Annex 2). The analysis conducted here shows that the current network of BEmOC facilities is indeed insufficient to reach universal accessibility and geographic coverage as per the definition used in the context of the present project (see Chapter 3);
    o The same observation can be made at the Region and Province levels (Table 2) as none of the sub-divisions reach the benchmark level set in the 2009 handbook:
- When it comes to CEmOC facilities (Table 2):
    o 21 facilities correspond to a national ratio of 0.62 CEmOC facility for 500,000 population which is also below benchmark level set in the 2009 handbook [2].
    o At sub national level, 3 Regions (23%) and 16 Provinces (35.5%) are above the benchmark level set in the handbook for geographic distribution of CEmOC facilities.
    o The current network of CEmOC facilities is nevertheless sufficient, and well located to be reached in less than 2 hours from any BEmOC facility, and this even in the 10 Regions that are presenting a CEmOC density below the UN benchmark, therefore complying to universal accessibility coverage as defined in the context of this project. Unfortunately, the discrepancies in the health facility data regarding the number of EmOC surgical teams does not allow us to confirm this from a geographic coverage perspective.

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These results could serve as a basis for revising the indicators considered in the 2009 handbook [2] as they clearly demonstrate the limitations that exist when only considering the density of facilities at the national or sub national level without taking into account:
- environmental factors influencing the distribution and the mobility of the population such as natural barriers like mountain or the hydrographic network;
- the fact that patients might seek care in a different Province than the one in which they are living.

The service utilization analyzes (see Section 7.3) illustrates that:
1. Around 10% of the 4,339 unattended home deliveries covered by the 2010 DHS [12] are located in areas further away than 2 hours from a BEmOC facilities. For these births, physical accessibility is a main barrier to accessing BEmOC and could explain unattended home deliveries;
2. An important percentage of unattended home deliveries (around 76%) occur within 2 hours of travel time of a BEmOC facility but our analysis estimates that there would not be enough capacity to cover the demand if they were to seek care in these facilities. In this case, availability of care is a major barrier that could explain unattended home deliveries. This being said, non-EmOC facilities might be located within 2 hours of travel time of the household where these unattended births took place;
3. The remaining 14% of the unattended home deliveries considered here are located within 2 hours of travel time of a BEmOC that would have enough capacity to cover the demand. In this case, neither accessibility nor availability of care appear to be main barriers to access BEmOC. This of course assumes that motorized transport is made available to women, and in fact, there may be barriers related to free movement, including both cultural barriers as well as financial barriers, which limit these women accessing and utilizing emergency obstetric care.

In view of the above, a scaling up analysis has been performed using two different scenarios:
- Scenario 1: Upgrading partially functional EmOC facilities identified during the 2010 EmONC needs assessment [17] to comply with BEmOC;
- Scenario 2: Considering establishing a waiting home near each BEmOC, including CEmOC, facilities for pregnant women having to travel more than two hours to reach a BEmOC facility.

When implementing the first scenario, geographic coverage for BEmOC reaches 69.2% at the national level which remains below the universal geographic coverage benchmark and would only gain 8.1% coverage compared to extending the coverage capacity of the 25 fully EmOC facilities to cover all the births where the household is located within 2 hours of travel time. In this case, the impact of on the CEmOC facilities in terms of the referral of births with complications was not analyzed.

With the second scenario, 649,814 births (427,144 where the household is located within 2 hours of travel time and 222,670 that would travel from further away before the due date and stay in waiting homes) could be covered by the BEmOC facilities, corresponding to a geographic coverage of 92.9% at the national level.

Universal geographic coverage would thereby be reached for both BEmOC and CEmOC but implementing this scenario would require the hiring and/or the transfer of over 3,000 skilled birth attendants for BEmOC, an important increase in the number of EmOC surgical teams as well as the need to solve working space and equipment (operating theaters) issues.

This second scenario therefore provides options to reach universal accessibility and geographic coverage for both BEmOC and CEmOC but this would incur significant cost that will have to be estimated. Several issues pertaining to input parameters, health facility level data and norms will first have to be addressed before reaching this stage in order to ensure more precise results.

While all results presented in this report are subject to the availability, quality (accuracy and level of completeness) and accessibility of data (see Chapter 6), and taking the above mentioned limitations into account, the findings to date allows for the identification of potential areas in which the government might want to perform more in-depth analyses.

The importance of quality data also underlines the need for the Ministry of Health to have a strong Health Information System (HIS) in which the geographic and time dimensions are well integrated. The Ministry of Health could take advantage of the present project work to improve this integration (see Chapter 8).

At the same time, and to fully benefit from the results that this type of analyzes can provide, it would be important to ensure that knowledge on the applied methods are transferred to the Ministry of Health of Burkina Faso and other relevant institutions. This concerns GIS in general and physical accessibility analysis in particular.

In view of the above, it is proposed that the Ministry of Health and WHO collaborate on the assessment of geographic access and to use the work presented here as a driver to strengthen the integration of geography and time in the HIS as well as the GIS capacity of the Ministry.

The following recommendations are therefore proposed for consideration:

For WHO to support the Ministry of Health and other relevant institutions when it comes to the:
- strengthening of GIS capacity in general and the ability to conduct analyzes such as the ones presented here;
- transfer of knowledge behind the methods and tools used in the present study;

- updating of the analysis to account for potential changes since the 2010 needs assessment in terms of both the number of EmOC infrastructures and associated human capacities.

For the Ministry of Health to:
- Provide feedback on the results obtained through the different analyzes presented here;
- Consider this project as an opportunity to strengthen its GIS capacity as well as to better integrate geography and time in the HIS;
- Consider the implementation of a follow up project in which:
    o the input data, norms and parameters would be validated/adjusted/revised in order to produce more precise results for decision making;
    o Additional scenarios could be developed and analysed in order to come up with the most cost effective scaling up option for extending emergency obstetric care services in Burkina Faso.

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Annex 1 – Indicators and minimum acceptable levels from the 1997 UNICEF, WHO, UNFPA Guidelines for monitoring the availability and use of obstetric services [1]

Indicator	Minimum acceptable level
Amount of essential obstetric care (EOC): **Basic EOC facilities** **Comprehensive EOC facilities**	For every **500,000 population**, there should be: **At least 4 Basic EOC facilities.** **At least 1 Comprehensive EOC facility.**
Geographical distribution of EOC facilities	Minimum level for amount of EOC services is met in subnational areas.
Proportion of all births in Basic and Comprehensive EOC facilities	**At least 15% of all births** in the population take place in either Basic or Comprehensive EOC facilities.
Met need for EOC: Proportion of women estimated to have complications who are treated in EOC facilities	At least 100% of women estimated to have obstetric complications are treated in EOC facilities.
Caesarean sections as a percentage of all births	As a proportion of all births in the population, Caesarean sections account for **not less than 5% nor more than 15%**.
Case fatality rate	The case fatality rate among women with obstetric complications in EOC facilities is **less than 1%**.

Annex 2 – Indicators and minimum acceptable levels from the 2009 WHO, UNFPA, UNICEF and Mailman School of Public Health handbook for monitoring emergency obstetric care [2]

Indicator	Acceptable level
1. Availability of emergency obstetric care: basic and comprehensive care facilities	There are at least five emergency obstetric care facilities (including at least one comprehensive facility) for every 500 000 population
2. Geographical distribution of emergency obstetric care facilities	All subnational areas have at least five emergency obstetric care facilities (including at least one comprehensive facility) for every 500 000 population
3. Proportion of all births in emergency obstetric care facilities[a]	(Minimum acceptable level to be set locally)
4. Met need for emergency obstetric care: proportion of women with major direct obstetric complications who are treated in such facilities[a]	100% of women estimated to have major direct obstetric complications[b] are treated in emergency obstetric care facilities
5. Caesarean sections as a proportion of all births[a]	The estimated proportion of births by caesarean section in the population is not less than 5% or more than 15%[c]
6. Direct obstetric case fatality rate[a]	The case fatality rate among women with direct obstetric complications in emergency obstetric care facilities is less than 1%

Annex 3 – Illustration of the current EmOC referral system in Burkina Faso
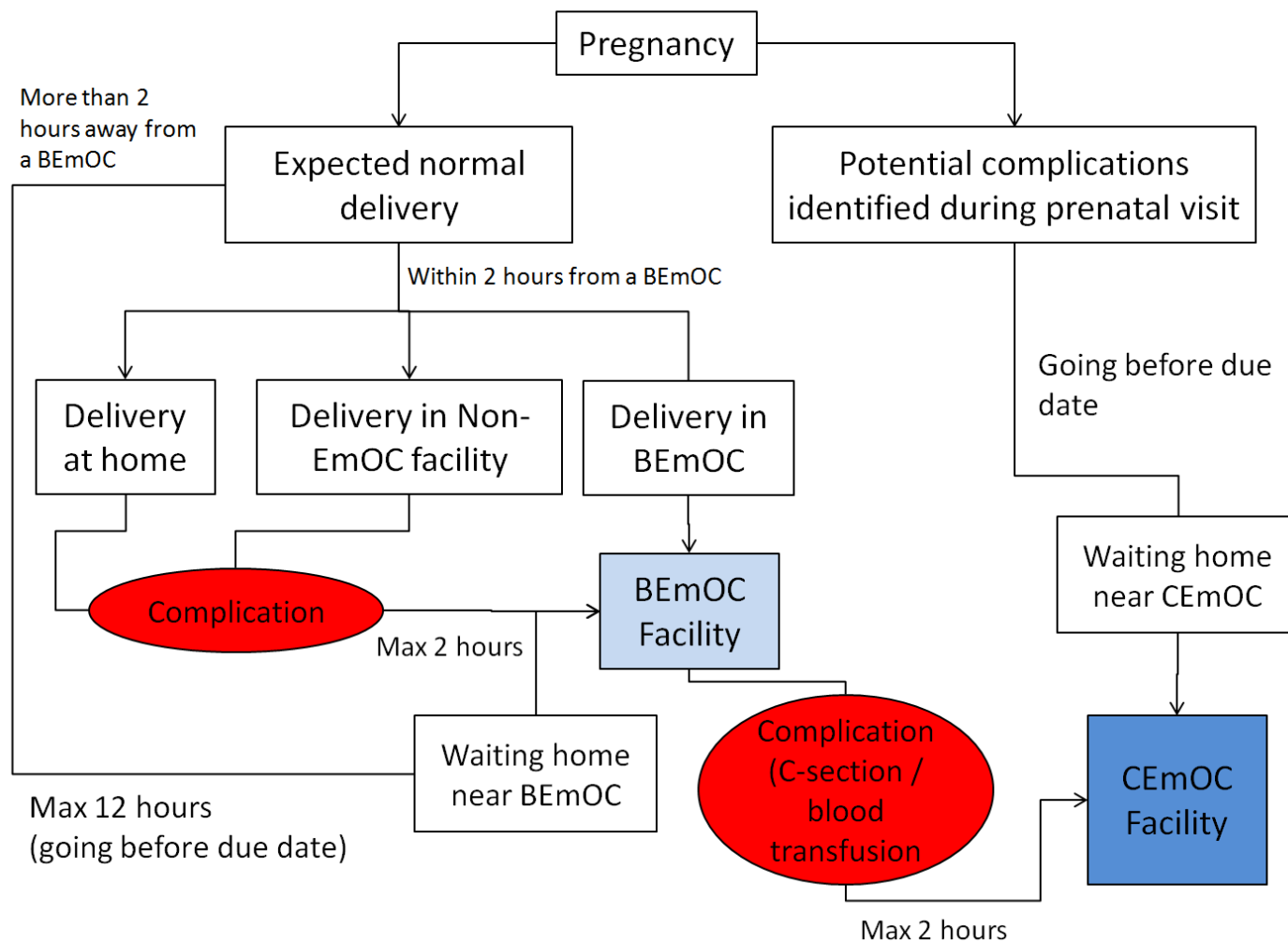
Annex 4 – Regional and Province level demographic data used in the context of the project

Region code [14]	Region Name [14]	Province code [14]	Province name [14]	2006 Regional level population [13]	2006 province level population [13]	Male / Ages Groups [13] 0 - 14 years	15 - 49 years	50 and aboved	Total Male [13]	Female / Ages Groups [13] 0-14	15-49	50+	Total Female [13]	2010 total fertility rate [12]	CBR (Census 2006 [13])	CBR (2006 census adjusted to 2010 DHS [10])	Population 2011 (Pop census 2006 [13] adjusted to Pop UN 2011 [10])	Province level estimated nbr of birth in 2011 (using CBR from census 2006 [13] & Pop 2011 [10])	Region level estimated nbr of birth in 2011 (using CBR from census 2006 [13] & Pop 2011 [10])
BFA046	Boucle du Mouhoun	BFA046001	Bale	1'442'749	213'423	357'803	288'563	67'976	105'582	339'242	313'169	75'996	107'841	6.8	42.6	38.3	258'350	9'900	71'490
		BFA046002	Banwa		269'375				132'052				137'323		48.6	43.7	326'080	14'256	
		BFA046003	Kossi		278'546				138'459				140'087		46.9	42.2	337'182	14'226	
		BFA046004	Mouhoun		297'350				148'089				149'261		44.9	40.4	359'944	14'538	
		BFA046005	Nayala		163'433				81'208				82'225		43.6	39.2	197'837	7'759	
		BFA046006	Sourou		220'622				108'952				111'670		45.0	40.5	267'065	10'811	
BFA047	Cascades	BFA047001	Comoe	531'808	407'528	125'330	112'155	23'883	201'453	121'190	125'567	23'683	206'075	6.0	47.0	42.3	493'316	20'857	27'340
		BFA047002	Leraba		124'280				59'915				64'365		47.9	43.1	150'442	6'482	
BFA013	Centre	BFA013000	Kadiogo	1'727'390	1'727'390	308'435	485'401	73'174	867'010	314'081	475'111	71'188	860'380	3.7	37.2	33.5	2'091'018	69'973	69'973
BFA048	Centre-Est	BFA048001	Boulgou	1'132'016	543'570	280'055	194'624	54'654	250'908	268'194	265'910	68'579	292'662	6.3	47.7	42.9	657'996	28'234	58'834
		BFA048002	Koulpelogo		258'667				125'276				133'391		50.5	45.4	313'118	14'224	
		BFA048003	Kouritenga		329'779				153'149				176'630		45.6	41.0	399'200	16'375	
BFA049	Centre-Nord	BFA049001	Bam	1'202'025	275'191	298'761	208'880	58'345	130'228	290'334	279'203	66'502	144'963	6.7	46.4	41.7	333'121	13'904	64'276
		BFA049002	Namentenga		328'820				157'079				171'741		53.2	47.9	398'039	19'049	
		BFA049003	Sanmatenga		598'014				278'679				319'335		48.1	43.3	723'900	31'322	
BFA050	Centre-Ouest	BFA050001	Boulkiemde	1'186'566	505'206	292'422	198'337	56'066	223'195	278'004	282'784	78'953	282'011	6.4	43.0	38.7	611'556	23'656	58'471
		BFA050002	Sanguie		297'036				137'548				159'488		45.0	40.5	359'564	14'555	
		BFA050003	Sissili		208'409				101'297				107'112		48.0	43.2	252'281	10'893	
		BFA050004	Ziro		175'915				84'785				91'130		48.9	44.0	212'946	9'367	
BFA051	Centre-Sud	BFA051001	Bazega	641'443	238'425	154'234	112'802	35'823	111'459	146'590	147'647	44'347	126'966	5.6	42.9	38.6	288'615	11'138	30'324
		BFA051002	Nahouri		157'071				76'152				80'919		41.4	37.2	190'136	7'081	
		BFA051003	Zoundweogo		245'947				115'248				130'699		45.2	40.7	297'721	12'105	
BFA052	Est	BFA052001	Gnagna	1'212'284	408'669	312'520	232'038	50'310	199'252	299'862	267'544	50'010	209'417	7.5	54.9	49.4	494'697	24'431	72'201
		BFA052002	Gourma		305'936				148'270				157'666		51.7	46.5	370'338	17'223	
		BFA052003	Komonjdjari		79'507				39'419				40'088		54.5	49.0	96'244	4'718	
		BFA052004	Kompienga		75'867				38'357				37'510		52.3	47.0	91'838	4'321	
		BFA052005	Tapoa		342'305				169'570				172'735		57.7	51.9	414'363	21'507	
BFA053	Hauts-Bassins	BFA053001	Houet	1'469'604	955'451	326'714	334'670	64'845	474'086	319'123	359'799	64'453	481'365	5.2	43.2	38.9	1'156'581	44'946	71'864
		BFA053002	Kenedougou		285'695				140'950				144'745		49.5	44.5	345'836	15'400	
		BFA053003	Tuy		228'458				111'193				117'265		46.3	41.6	276'550	11'518	
BFA054	Nord	BFA054001	Loroum	1'185'796	142'853	298'761	208'880	58'345	67'590	290'334	279'203	66'502	75'263	6.2	49.5	44.5	172'925	7'700	59'048
		BFA054002	Passore		323'222				149'146				174'076		43.6	39.2	391'263	15'346	
		BFA054003	Yatenga		553'164				261'272				291'892		46.1	41.5	669'609	27'769	
		BFA054004	Zondoma		166'557				76'684				89'873		45.4	40.8	201'618	8'234	
BFA055	Plateau Central	BFA055001	Ganzourgou	696'372	319'380	171'741	116'310	36'537	149'969	164'347	162'640	44'797	169'411	5.8	47.7	42.9	386'612	16'589	35'121
		BFA055002	Kourweogo		138'217				62'157				76'060		42.8	38.5	167'313	6'442	
		BFA055003	Oubritenga		238'775				112'462				126'313		46.5	41.8	289'039	12'090	
BFA056	Sahel	BFA056001	Oudalan	968'442	195'964	233'118	196'726	51'531	97'563	223'558	215'228	48'281	98'401	7.5	44.0	39.6	237'216	9'389	51'557
		BFA056002	Seno		264'991				131'754				133'237		49.0	44.1	320'774	14'139	
		BFA056003	Soum		347'335				171'505				175'830		49.9	44.9	420'452	18'873	
		BFA056004	Yagha		160'152				80'553				79'599		52.5	47.2	193'865	9'156	
BFA057	Sud-Ouest	BFA057001	Bougouriba	620'767	101'479	152'672	114'381	32'211	49'440	140'957	140'419	40'127	52'039	6.4	43.7	39.3	122'841	4'829	29'234
		BFA057002	Ioba		192'321				93'245				99'076		41.1	37.0	232'806	8'607	
		BFA057003	Noumbiel		70'036				34'241				35'795		43.9	39.5	84'779	3'348	
		BFA057004	Poni		256'931				122'338				134'593		44.5	40.0	311'017	12'450	
			Country Total	14'017'262	14'017'262	3'307'186	2'795'982	665'571	6'768'739	3'192'025	3'302'636	753'862	7'248'523	6.0	45.8	41.2	16'968'000	699'735	699'735

Color legend:

Collected statistical data

Calculated variables

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Annex 5 – 2010 list of BEmOC and CEmOC facilities identified during the obstetrical and neonatal care emergency needs assessment [17]

EmOC Code	Fiche number	EmOC Type	Region Name	Province Name	Facility Name	Facility Type	Latitude	Longitude	Northing	Easting
C15	3627	CEmOC	Boucle du Mouhoun	Banwa	CMA de Solenzo	CMA	12.1833000	-4.0833000	1347057.871	382146.7858
C13	3807	CEmOC	Boucle du Mouhoun	Mouhoun	CHR de Dedougou	CHR	12.4546000	-3.4636170	1376867.2	449616.7217
C5	3733	CEmOC	Boucle du Mouhoun	Sourou	CMA de Tougan	CMA	13.0666667	-3.0667000	1444509.112	492768.8952
C20	3436	CEmOC	Cascades	Comoe	CHR de Banfora	CHR	10.6333000	-4.7500000	1175973.313	308562.9433
B3	439	BEmOC	Centre	Kadiogo	Centre médical Saint Camille	CM	12.3816299	-1.5045256	1369209.129	662580.2633
C4	6402	CEmOC	Centre	Kadiogo	CHU Yalgado Ouedraogo	CHU	12.3772744	-1.5154161	1368720.74	661398.738
C10	720	CEmOC	Centre	Kadiogo	Clinique Kone Moussa	CMA	12.3666332	-1.4978716	1367554.317	663313.125
C11	417	CEmOC	Centre	Kadiogo	CMA du secteur 30	CMA	12.3386524	-1.4954616	1364460.673	663592.5891
C16	24	CEmOC	Centre	Kadiogo	CMA du secteur 26	CMA	12.3646370	-1.5338639	1367311.791	659400.4204
B1	1710	BEmOC	Centre-Est	Boulgou	CSPS de Zonse	CSPS	11.3548700	-0.6353970	1256266.959	758072.4467
B2	5706	BEmOC	Centre-Est	Kouritenga	CM de Pouytenga	CM	12.2487403	-0.4266584	1355393.569	779958.3946
C12	1225	CEmOC	Centre-Nord	Bam	CMA de Kongoussi	CMA	13.3333333	-1.5333333	1474467.215	658848.0024
C21	1135	CEmOC	Centre-Nord	Sanmatenga	CHR de Kaya	CHR	13.0833333	-1.0833333	1447138.309	707811.4047
C14	1628	CEmOC	Centre-Ouest	Boulkiemde	CHR de Koudougou	CHR	12.2562183	-2.3517526	1354970.682	570501.6521
B4	2802	BEmOC	Est	Gnagna	CSPS de Piela	CSPS	12.7102770	-0.1325000	1406812.41	811430.5866
C19	2931	CEmOC	Est	Gourma	CHR de Fada	CHR	12.0548100	0.3609720	1334858.21	865991.1876
C1	4123	CEmOC	Hauts-Bassins	Houet	CMA de Do	CMA	11.2002558	-4.2978557	1238433.722	358302.5415
C3	4026	CEmOC	Hauts-Bassins	Houet	Clinique Lorentia	CMA	11.1695605	-4.3100256	1235044.736	356958.5807
C18	4420	CEmOC	Hauts-Bassins	Houet	CHU Souro Sanou	CHU	11.1702692	-4.3016251	1235119.066	357876.322
C9	4007	CEmOC	Hauts-Bassins	Kenedougou	CMA de Orodara	CMA	10.9737800	-4.9081580	1213741.399	291491.0926
C2	4215	CEmOC	Hauts-bassins	Tuy	CMA de Hounde	CMA	11.4882700	-3.5178170	1270019.381	443526.1104
C17	2328	CEmOC	Plateau Central	Ganzourgou	CMA de Zorgho	CMA	12.2471215	-0.6281412	1355013.497	758028.3339
C7	3222	CEmOC	Sahel	Seno	CHR Dori	CHR	14.0246473	-0.0233208	1552477.692	821548.1529
C6	4623	CEmOC	Sud-Ouest	Bougouriba	CMA de Diebougou	CMA	10.9666667	-3.2500000	1212305.095	472685.8945
C8	4713	CEmOC	Sud-Ouest	Poni	CHR de Gaoua	CHR	10.3249800	-3.1737090	1141348.946	480981.4671

Legend for health facility types:

CSPS : Health and social promotion center

CMA : Medical center with surgical antenna

CM : Private medical center

CHU : University hospital

CHR : Regional hospital

Annex 6 – EmOC number of skilled birth attendant, medical staff qualified to perform a C-section or an anaesthesiology and assisted deliveries for 2012

EmOC Code	Fiche number	EmOC Type	Facility name	Skilled birth attendants [17]								Medical staff qualified to perform a C-section [17]				Medical staff qualified to perform an anesthesiology [17]		Number of assisted deliveries (MOH, 2012)
				Auxiliary midwifes (Accoucheuses auxilliaires)	Patented midwifes (Accoucheuses brevetées)	State midwifes (Sage Femmes d'Etat)	Nurses specialized in nursing and midwifery (Infirmiers spécialisés en soins infirmiers et obstétricaux)	Patented nurses (Infirmiers breveté)	Registered State Nurses (Infirmiers diplômé d'Etat)	General practitioner (Médecins généralistes)	Total number of Skilled Birth attendants	Emergency physicians (Médecins urgentistes)	Gynecologists (Gynécologues)	General surgeons (Chirurgiens généralistes)	Nurses specialized in surgery (Infirmiers spécialisés en chirurgie)	Anaesthetists (Médecins anesthésistes)	Nurses specialized in anaesthesiology (Infirmiers spécialisés en anesthésie)	
B1	1710	BEmOC	CSPS de Zonse	1	0	0	0	0	2	0	3	0	0	0	0	0	0	553
B2	5706	BEmOC	CM de Pouytenga	7	0	8	1	17	10	2	45	0	0	0	0	0	0	2,909
B3	439	BEmOC	Centre médical Saint Camille	12	0	25	0	8	15	3	63	0	1	0	0	0	0	1,922
B4	2802	BEmOC	CSPS de Piela	0	0	1	0	5	3	0	9	0	0	0	0	0	0	2,053
C1	4123	CEmOC	CMA de Do	0	0	22	2	11	25	3	63	4	1	0	9	0	8	4,553
C2	4215	CEmOC	CMA de Hounde	0	1	14	0	9	19	3	46	2	0	0	6	0	5	1,728
C3	4026	CEmOC	Clinique Lorentia	1	0	2	0	0	2	0	5	0	2	0	2	0	0	384
C4	6402	CEmOC	CHU Yalgado Ouedraogo	0	0	32	4	67	132	15	250	0	12	10	57	8	67	6,201
C5	3733	CEmOC	CMA de Tougan	0	0	16	0	9	16	4	45	3	0	0	5	0	2	415
C6	4623	CEmOC	CMA de Diebougou	3	0	9	0	14	17	2	45	2	0	0	3	0	3	445
C7	3222	CEmOC	CHR Dori	0	0	11	0	12	36	8	67	0	2	2	7	0	9	888
C8	4713	CEmOC	CHR de Gaoua	0	0	15	0	16	0	4	35	0	1	0	14	1	0	666
C9	4007	CEmOC	CMA de Orodara	6	0	10	0	1	8	3	28	2	0	0	6	0	5	309
C10	720	CEmOC	Clinique Kone Moussa	0	0	8	0	0	0	11	19	0	12	0	1	1	1	NA
C11	417	CEmOC	CMA du secteur 30	0	0	25	0	30	39	5	99	1	5	2	11	1	16	2,438
C12	1225	CEmOC	CMA de Kongoussi	6	1	12	0	17	20	2	58	2	0	0	4	0	4	1,131
C13	3807	CEmOC	CHR de Dedougou	0	0	14	1	22	21	4	62	0	1	1	7	0	7	1,080
C14	1628	CEmOC	CHR de Koudougou	0	0	20	2	33	53	6	114	0	2	1	16	1	12	1,976
C15	3627	CEmOC	CMA de Solenzo	0	0	14	0	10	26	3	53	3	0	0	4	0	2	365
C16	24	CEmOC	CMA du secteur 26	9	0	14	0	5	11	3	42	0	4	0	0	0	0	2,753
C17	2328	CEmOC	CMA de Zorgho	1	0	11	0	8	20	3	43	3	0	0	3	0	4	253
C18	4420	CEmOC	CHU Souro Sanou	4	0	36	2	104	114	14	274	0	8	2	47	3	34	4,388
C19	2931	CEmOC	CHR de Fada	5	0	17	1	31	42	4	100	2	2	1	14	0	8	1,428
C20	3436	CEmOC	CHR de Banfora	7	0	15	0	33	36	5	96	0	1	1	12	0	8	1,650
C21	1135	CEmOC	CHR de Kaya	2	0	14	1	14	50	5	86	0	1	1	15	1	9	1,603
			Total	64	2	365	14	476	717	112	1750	24	55	21	243	16	204	42,091

Annex 7 – Simplified classification for the global land cover distribution grid [18]

Original_class _code	original_class_name	Simplified_class_code	Simplified_class_name
1	Broadleaf Evergreen Forest	5	Dense vegetation
2	Broadleaf Deciduous Forest	5	Dense vegetation
3	Needleleaf Evergreen Forest	5	Dense vegetation
4	Needleleaf Deciduous Forest	5	Dense vegetation
5	Mixed Forest	5	Dense vegetation
6	Tree Open	4	Medium dense vegetation
7	Shrub	5	Dense vegetation
8	Herbaceous	3	Low dense vegetation
9	Herbaceous with Sparse Tree/Shrub	3	Low dense vegetation
10	Sparse vegetation	4	Medium dense vegetation
11	Cropland	4	Medium dense vegetation
12	Paddy field	5	Dense vegetation
13	Cropland / Other Vegetation Mosaic	4	Medium dense vegetation
14	Mangrove	6	Water
15	Wetland	6	Water
16	Bare area,consolidated(gravel,rock)	1	Bare areas
17	Bare area,unconsolidated (sand)	1	Bare areas
18	Urban	2	Urban
20	Water bodies	6	Water

Annex 8 – Process followed in order to create the final land cover distribution grid

This annex describes the steps followed in order to generate the country specific land cover distribution grids used in the context of the present project.

Before applying the process, the following layers, projected according to the country specific UTM projection (see chapter 6) have to be added in ArcGIS (see section 6.2.3):
- The land cover distribution grid developed in the context of the Global Mapping project [18];
- The urban extend distribution layer developed in the context of the Global Rural-Urban Mapping Project (GRUMP) [19];

From there, the following steps are following in ArcGIS:
1. Reclassify the land cover distribution grid using the simplify list of classes reported in Annex 7;
2. Reclassify the GRUMP urban/rural mask for the urban areas to appear as "NoData" and the rual ones with the value "1";
3. Use the Spatial Analyst Tools>Math>Times tool from ArcGIS to multiply the reclassified lancover distribution grid from step 1 with the reclassified GRUMP layer from point 2 and save the result in a new file. This will generate "NoData" holes in the land cover layer where there are urban areas in GRUMP
4. Reclassify the "NoData" category from the raster layer resulting from step 3 into category 2 (Urban areas) nd save the result in a new file
5. Reclassify category 6 (Water) from the grid generated under point 4 into the "No Data" category and save the result in the final file. Doing this reduces the calculation time when using AccessMod

Annex 9 – Process to generate the buffers around the DHS cluster location

This annex describes the process that has been used in order to generate a buffer around the location of the cluster for which non-assisted home deliveries figures were available as part of the most recent DHS survey.

Starting from the excel file generated with the process reported in section the following steps are applied in ArcGIS in order to generate the buffers for which data is available:

1. In the view, add:
    a. the shape file containing the location of the DHS cluster (directly available from MEASURE DHS on request) in the view
    b. The administrative boundaries layers
    c. The water bodies layer (part of the hydrographic network)
    d. the excel file generated under section 6.1.3
2. Project the MEASURE DHS shape file into the country specific coordinate system selected for this project (see Chapter 6)
3. Join the excel file with the attribute table of the shape file using the DHS cluster code
4. Open the attribute table and select all the records for which there is a figure when it comes to non-assisted home deliveries
5. Right click on the shape file name in the table of content, select the Data>Export Data function and save the selected data in a new shape file
6. Add the new shape file created under step 5 in the view and open its attribute table. From there:
    a. Add a new field named BUFFER
    b. Put the shape file in editing mode
    c. Sort the attribute table according to the URBAN_RURAL field and use the field calculator to attribute a value of 5000 to clusters located in urban areas (U) and 10000 to clusters located in rural areas in the BUFFER column. These values corresponds to the radius, expressed in meters, of the buffer we will be creating in the next step
    d. Stop editing saving the changes which have been made
7. Use the Analysis Tools>Proximity>Buffer from ArcGIS Toolbox specifying the layer generated under step 5 as the input layer, BUFFER as the field to be used as the distance value and providing a name for the output file. This step will generate a buffer of 5 km radius around each rural cluster and of 10 km around each rural cluster.
8. Add the buffer layer created under step 7 in the view
9. Use the Data Management Tools>Generalization>Dissolve tool from ArcGIS toolbox to transform the administrative boundaries layer into a unique polygon containing the border of the country.

10. Use the Analysis Tools>Extract>Clip tool from ArcGIS toolbox to remove the part of the buffer located outside of the country from the buffer layer generated under step 7. Figure A shows an example of two buffers before and after the application of this step.

a)   b)
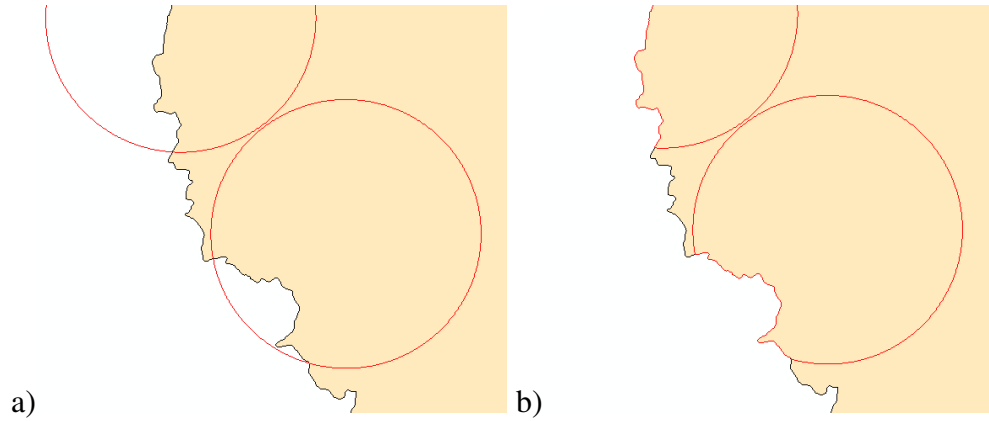
Figure A - Example of two buffers before (a) and after (b) the application of the clip tool on the cluster buffer layer

11. Put the cluster buffer layer in the editing mode and, using the water bodies' layer as a reference; manually cut the parts of the buffers falling on large water bodies. This step is performed in order to avoid having some of the random points located on water bodies when creating the maps. Figure B shows an example for few buffers before and after applying this step.

a)   b)
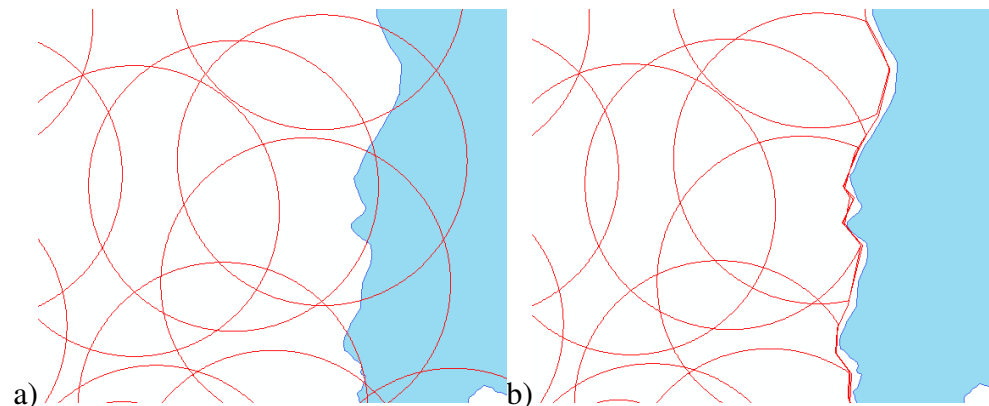
Figure B - Example of buffers before (a) and after (b) having manually cut the parts located on large water bodies

12. Stop the editing mode saving the file under a new name
13. Use the Tools>Generalization>Dissolve tool from ArcGIS toolbox on the cluster ID column to merge together part of buffer which might have been generated

during the above editing process and save the resulting shape file under a final name.

Annex 10 – Protocol used to spatially distribute the number of birth in each country

This annex describes the steps (Figure C) followed to generate the birth distribution grid used in the context of the present project.
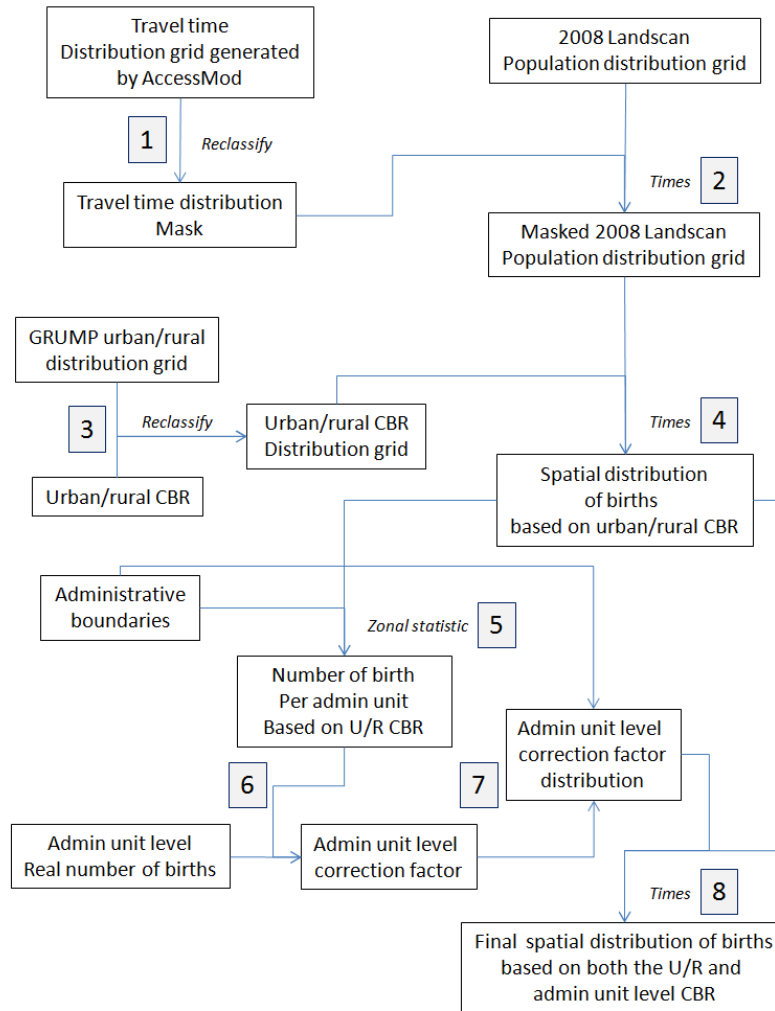
Figure C – Process used to generate total number of births spatial distribution grid

Before applying the process described in Figure C, the following layers, projected according to the country specific UTM projection (See Chapter 6), and resampled to match the resolution used in the context of this project for raster GRIDS, have to be added in ArcGIS:

- 2008 Landscan population distribution grid [19].

- Travel time distribution grid resulting from the application of the second module of AccessMod (see section 7.1);
- Province boundaries (see section 6.2.1)
- GRUMP urban-rural mask (see section 6.2.3)

In addition to that, the following data is to be available in an excel file for use during the process:

- National level urban/rural Crude Birth Rate (CBR) (see section 6.1.1);
- Province level number of birth (Annex 4).

From there, the following steps have been applied in ArcGIS:

1. Reclassify the travel time distribution grid resulting from the application of the second module of AccessMod to obtain a mask in which any cell located outside of the country, corresponding to water areas or being inaccessible by feet or motor vehicle are attributed a value of "0" while all the other cells containing a travel time are attributed a value of "1";
2. Apply the mask generated under point 1 to the resampled 2008 landscan population distribution grid using the Spatial Analyst > Math > Times tool in ArcGIS;
3. Reclassify the GRUMP urban/rural mask to obtain the spatial distribution the urban/rural CBR figures identified for the country;
4. Multiply the grid resulting from step 3 with the 2008 Landscan population distribution grid on which the travel time mask has been applied in step 2 to obtain the spatial distribution of births based on the urban/rural CBR;
5. Use the Province boundaries layer in raster format as the input layer in the Spatial Analyst>Zonal>Zonal Statistics tool in ArcGIS to extract the total number of birth per administrative divisions from the grid generated in step 4 and save the result as a dbf file;
6. Import the dbf resulting from step 5 in Excel and calculate a Province level specific correction factor to be applied on the spatial distribution of births obtained under step 4 to get the consistency with the total number of birth observed in each Province;
7. Join the resulting correction factor table to the attribute table of the Province boundaries layer using the common code and convert the shape file into a raster grid presenting the same resolution than the population distribution grid using the Conversion Tools>To Raster>Polygon to Raster tool in ArcGIS (please set the extent of the resulting grid to match the travel time distribution grid and snap it to this grid as well by specifying it in the Environment settings>General Settings window that can be opened from the bottom of the Polygon to Raster tool data input window);
8. Multiply the grid obtained under point 7 with the spatial distribution of births obtained under point 4 to obtain the final spatial distribution of births based on both the country level Urban/Rural CBR and Province level number of births.

Annex 11 – Regional and Province level number and percentage of births where the household is located within 2 hours of travel time to a BEmOC (including CEmOC) facility for both scenarios

Region code [14]	Region Name [14]	Province code [14]	Province name [14]	Province level estimated nbr of birth in 2011 (using CBR from census 2006 [13] & Pop 2011 [10])	Region level estimated nbr of birth in 2011 (using CBR from census 2006 [13] & Pop 2011 [10])	Province level number of births located within 2 hours of travel to a BEmOC (including CEmOC) with the combined walking + vehicle scenario	Region level number of births located within 2 hours of travel to a BEmOC (including CEmOC) with the combined walking + vehicle scenario	Province level percentage of births located within 2 hours of travel to a BEmOC (including CEmOC) with the combined walking + vehicle scenario	Region level percentage of births located within 2 hours of travel to a BEmOC (including CEmOC) with the combined walking + vehicle scenario	Number of births located within 2 hours of travel to a BEmOC (including CEmOC) when walking only	Percentage of births located within 2 hours of travel to a BEmOC (including CEmOC) when walking only
BFA046	Boucle du Mouhoun	BFA046001	Bale	9,900	71,490	6,076	42,733	61.4%	59.8%	0	0.0%
		BFA046002	Banwa	14,256		8,672		60.8%		713	5.0%
		BFA046003	Kossi	14,226		6,292		44.2%		0	0.0%
		BFA046004	Mouhoun	14,538		8,926		61.4%		1,640	11.3%
		BFA046005	Nayala	7,759		4,520		58.3%		0	0.0%
		BFA046006	Sourou	10,811		8,246		76.3%		365	3.4%
BFA047	Cascades	BFA047001	Comoe	20,857	27,340	12,182	15,505	58.4%	56.7%	1,846	8.8%
		BFA047002	Leraba	6,482		3,324		51.3%		0	0.0%
BFA013	Centre	BFA013000	Kadiogo	69,973	69,973	67,809	67,809	96.9%	96.9%	46,895	67.0%
BFA048	Centre-Est	BFA048001	Boulgou	28,234	58,834	16,858	35,525	59.7%	60.4%	247	0.9%
		BFA048002	Koulpelogo	14,224		6,462		45.4%		0	0.0%
		BFA048003	Kouritenga	16,375		12,205		74.5%		1,646	10.1%
BFA049	Centre-Nord	BFA049001	Bam	13,904	64,276	11,240	46,055	80.8%	71.7%	643	4.6%
		BFA049002	Namentenga	19,049		12,126		63.7%		0	0.0%
		BFA049003	Sanmatenga	31,322		22,689		72.4%		1,547	4.9%
BFA050	Centre-Ouest	BFA050001	Boulkiemde	23,656	58,471	17,904	36,614	75.7%	62.6%	3,347	14.1%
		BFA050002	Sanguie	14,555		9,855		67.7%		0	0.0%
		BFA050003	Sissili	10,893		4,379		40.2%		0	0.0%
		BFA050004	Ziro	9,367		4,476		47.8%		0	0.0%
BFA051	Centre-Sud	BFA051001	Bazega	11,138	30,324	5,334	17,477	47.9%	57.6%	0	0.0%
		BFA051002	Nahouri	7,081		4,344		61.4%		0	0.0%
		BFA051003	Zoundweogo	12,105		7,799		64.4%		101	0.8%
BFA052	Est	BFA052001	Gnagna	24,431	72,201	13,119	26,082	53.7%	36.1%	379	1.6%
		BFA052002	Gourma	17,223		10,128		58.8%		1,584	9.2%
		BFA052003	Komonjdjari	4,718		1,223		25.9%		0	0.0%
		BFA052004	Kompienga	4,321		952		22.0%		0	0.0%
		BFA052005	Tapoa	21,507		661		3.1%		0	0.0%
BFA053	Hauts-Bassins	BFA053001	Houet	44,946	71,864	30,726	44,413	68.4%	61.8%	18,436	41.0%
		BFA053002	Kenedougou	15,400		7,463		48.5%		464	3.0%
		BFA053003	Tuy	11,518		6,224		54.0%		347	3.0%
BFA054	Nord	BFA054001	Loroum	7,700	59,048	2,285	32,753	29.7%	55.5%	0	0.0%
		BFA054002	Passore	15,346		9,707		63.3%		0	0.0%
		BFA054003	Yatenga	27,769		16,140		58.1%		0	0.0%
		BFA054004	Zondoma	8,234		4,621		56.1%		0	0.0%
BFA055	Plateau Central	BFA055001	Ganzourgou	16,589	35,121	10,439	22,496	62.9%	64.1%	507	3.1%
		BFA055002	Kourweogo	6,442		4,295		66.7%		0	0.0%
		BFA055003	Oubritenga	12,090		7,763		64.2%		0	0.0%
BFA056	Sahel	BFA056001	Oudalan	9,389	51,557	2,992	21,400	31.9%	41.5%	0	0.0%
		BFA056002	Seno	14,139		9,037		63.9%		879	6.2%
		BFA056003	Soum	18,873		7,768		41.2%		0	0.0%
		BFA056004	Yagha	9,156		1,603		17.5%		0	0.0%
BFA057	Sud-Ouest	BFA057001	Bougouriba	4,829	29,234	3,484	18,280	72.1%	62.5%	280	5.8%
		BFA057002	Ioba	8,607		5,470		63.6%		0	0.0%
		BFA057003	Noumbiel	3,348		1,850		55.3%		0	0.0%
		BFA057004	Poni	12,450		7,476		60.0%		478	3.8%
			Country total/percentage:	699,735	699,735	427,144	427,144	61.0%	61.0%	82,343	11.8%

Color legend:
Values obtained with AccessMod
Calculated variables

Annex 12 – Travel time between each BEmOC (including CEmOC) and the nearest CEmOC

EmOC Code	EmOC Type	Region name	Province name	Facility name	travel time to the nearest CEmOC facility (Min)	Code of the nearest CEmOC facility	Name of the Nearest CEmOC facility
C15	CEmOC	Boucle du Mouhoun	Banwa	CMA de Solenzo	0	C15	CMA de Solenzo
C13	CEmOC	Boucle du Mouhoun	Mouhoun	CHR de Dedougou	0	C13	CHR de Dedougou
C5	CEmOC	Boucle du Mouhoun	Sourou	CMA de Tougan	0	C5	CMA de Tougan
C20	CEmOC	Cascades	Comoe	CHR de Banfora	0	C20	CHR de Banfora
C10	CEmOC	Centre	Kadiogo	Clinique Kone Moussa	0	C10	Clinique Kone Moussa
C11	CEmOC	Centre	Kadiogo	CMA du secteur 30	0	C11	CMA du secteur 30
C16	CEmOC	Centre	Kadiogo	CMA du secteur 26	0	C16	CMA du secteur 26
C4	CEmOC	Centre	Kadiogo	CHU Yalgado Ouedraogo	0	C4	CHU Yalgado Ouedraogo
B3	BEmOC	Centre	Kadiogo	Centre Medical Saint Camille	1.2	C4	CHU Yalgado Ouedraogo
B2	BEmOC	Centre-Est	Kouritenga	CM de Pouytenga	23.2	C17	CMA de Zorgho
B1	BEmOC	Centre-Est	Boulgou	CSPS de Zonse	113.8	C17	CMA de Zorgho
C12	CEmOC	Centre-Nord	Bam	CMA de Kongoussi	0	C12	CMA de Kongoussi
C21	CEmOC	Centre-Nord	Sanmatenga	CHR de Kaya	0	C21	CHR de Kaya
C14	CEmOC	Centre-Ouest	Boulkiemde	CHR de Koudougou	0	C14	CHR de Koudougou
C19	CEmOC	Est	Gourma	CHR de Fada	0	C19	CHR de Fada
B4	BEmOC	Est	Gnagna	CSPS de Piela	84.5	C19	CHR de Fada
C1	CEmOC	Hauts-Bassins	Houet	CMA de Do	0	C1	CMA de Do
C18	CEmOC	Hauts-Bassins	Houet	CHU Souro Sanou	0	C18	CHU Souro Sanou
C3	CEmOC	Hauts-Bassins	Houet	Clinique Lorentia	0	C3	Clinique Lorentia
C9	CEmOC	Hauts-Bassins	Kenedougou	CMA de Orodara	0	C9	CMA de Orodara
C2	CEmOC	Hauts-Bassins	Tuy	CMA de Hounde	0	C2	CMA de Hounde
C17	CEmOC	Plateau Central	Ganzourgou	CMA de Zorgho	0	C17	CMA de Zorgho
C7	CEmOC	Sahel	Seno	CHR Dori	0	C7	CHR Dori
C6	CEmOC	Sud-Ouest	Bougouriba	CMA de Diebougou	0	C6	CMA de Diebougou
C8	CEmOC	Sud-Ouest	Poni	CHR de Gaoua	0	C8	CHR de Gaoua

Annex 13 – Province level travel time statistics

Region code [14]	Region Name [14]	Province code [14]	Province name [14]	Nbr of BEmOC, including CEmOC, facilities in the province	Nbr of CEmOC facilities in the province	Closest BEmOC facility to the province	Travel time to the nearest BEmOC facility (hours)		
							MIN	MAX	MEAN (birth weighted)
BFA046	Boucle du Mouhoun	BFA046001	Bale	0	0	C2	0.3	15.9	2.3
		BFA046002	Banwa	1	1	C15	0	18.8	2.4
		BFA046003	Kossi	0	0	C13	0.2	12.3	2.6
		BFA046004	Mouhoun	1	1	C13	0	15.1	2.2
		BFA046005	Nayala	0	0	C5, C13	0.2	10.9	2.2
		BFA046006	Sourou	1	1	C5	0	8.7	1.4
BFA047	Cascades	BFA047001	Comoe	1	1	C20	0	26.4	3.0
		BFA047002	Leraba	0	0	C20	0.3	11.7	2.8
BFA013	Centre	BFA013000	Kadiogo	5	4	B3, C4, C10, C11, C16	0	11.2	0.3
BFA048	Centre-Est	BFA048001	Boulgou	1	0	B1	0	21.0	2.4
		BFA048002	Koulpelogo	0	0	C19	0.6	23.8	3.3
		BFA048003	Kouritenga	1	0	B2	0	6.9	1.3
BFA049	Centre-Nord	BFA049001	Bam	1	1	C12	0	7.1	1.3
		BFA049002	Namentenga	0	0	B4, C7, C21	0.2	9.4	2.0
		BFA049003	Sanmatenga	1	1	C21	0	10.9	1.5
BFA050	Centre-Ouest	BFA050001	Boulkiemde	1	1	C14	0	7.7	1.3
		BFA050002	Sanguie	0	0	C14	0.1	17.4	2.0
		BFA050003	Sissili	0	0	C14	0.7	21.7	3.3
		BFA050004	Ziro	0	0	C14	0.6	20.5	3.5
BFA051	Centre-Sud	BFA051001	Bazega	0	0	C11	0.3	22.5	3.1
		BFA051002	Nahouri	0	0	B1	0.5	20.0	2.6
		BFA051003	Zoundweogo	0	0	B1	0.1	15.6	2.2
BFA052	Est	BFA052001	Gnagna	1	0	B4	0	14.6	2.5
		BFA052002	Gourma	1	1	C19	0	26.8	2.9
		BFA052003	Komonjdjari	0	0	C19	0.8	21.8	4.1
		BFA052004	Kompienga	0	0	C19	0.6	49.8	10.3
		BFA052005	Tapoa	0	0	C19	1.5	39.1	6.6
BFA053	Hauts-Bassins	BFA053001	Houet	3	3	C1, C3, C18	0	19.1	2.0
		BFA053002	Kenedougou	1	1	C9	0	23.1	2.9
		BFA053003	Tuy	1	1	C2	0	18.5	2.7
BFA054	Nord	BFA054001	Loroum	0	0	C12	0.9	9.3	3.0
		BFA054002	Passore	0	0	C12, C14	0.6	8.3	2.2
		BFA054003	Yatenga	0	0	C5, C12	0.4	8.6	2.2
		BFA054004	Zondoma	0	0	C5	0.8	7.0	2.3
BFA055	Plateau Central	BFA055001	Ganzourgou	1	1	C17	0	14.0	2.0
		BFA055002	Kourweogo	0	0	C4, C16	0.3	7.6	1.8
		BFA055003	Oubritenga	0	0	C4	0.2	8.6	1.9
BFA056	Sahel	BFA056001	Oudalan	0	0	C7	0.3	15.0	3.8
		BFA056002	Seno	1	1	C7	0	9.7	1.9
		BFA056003	Soum	0	0	C7, C12	0.8	13.9	3.0
		BFA056004	Yagha	0	0	B4, C7	0.7	16.3	4.3
BFA057	Sud-Ouest	BFA057001	Bougouriba	1	1	C6	0	17.2	1.7
		BFA057002	Ioba	0	0	C6	0.2	12.5	2.0
		BFA057003	Noumbiel	0	0	C8	0.4	14.5	2.7
		BFA057004	Poni	1	1	C8	0	13.4	2.3

	Total	25	21

Annex 14 – Health facility level results of the geographic coverage analysis for BEmOC (including CEmOC) facilities

EmOC Code	Fiche number	EmOC type	Region name	Province name	Facility name	Maximum coverage capacity	AccessMod processing order	Travel time at the catchment area border (min)	Normal deliveries covered	Coverage capacity not used	Number of assisted deliveries (MOH, 2012)
C4	6402	CEmOC	Centre	Kadiogo	CHU Yalgado Ouedraogo	6,201	1	2	6,201	0	6,201
C18	4420	CEmOC	Hauts-Bassins	Houet	CHU Souro Sanou	5,295	2	2	5,295	0	4,388
C1	4123	CEmOC	Hauts-Bassins	Houet	CMA de Do	4,553	3	3	4,553	0	4,553
B2	5706	BEmOC	Centre-Est	Kouritenga	CM de Pouytenga	2,909	4	15	2,909	0	2,909
C16	24	CEmOC	Centre	Kadiogo	CMA du secteur 26	2,753	5	1	2,753	0	2,753
C11	417	CEmOC	Centre	Kadiogo	CMA du secteur 30	2,438	6	2	2,438	0	2,438
B4	2802	BEmOC	Est	Gnagna	CSPS de Piela	2,053	7	28	2,053	0	2,053
C14	1628	CEmOC	Centre-Ouest	Boulkiemde	CHR de Koudougou	1,976	8	3	1,976	0	1,976
B3	439	BEmOC	Centre	Kadiogo	Centre Medical Saint Camille	1,922	9	2	1,922	0	1,922
C2	4215	CEmOC	Hauts-bassins	Tuy	CMA de Hounde	1,728	10	26	1,728	0	1,728
C20	3436	CEmOC	Cascades	Comoe	CHR de Banfora	1,650	11	4	1,650	0	1,650
C21	1135	CEmOC	Centre-Nord	Sanmatenga	CHR de Kaya	1,603	12	8	1,603	0	1,603
C19	2931	CEmOC	Est	Gourma	CHR de Fada	1,428	13	6	1,428	0	1,428
C13	3807	CEmOC	Boucle du Mouhoun	Mouhoun	CHR de Dedougou	1,369	14	3	1,369	0	1,080
C7	3222	CEmOC	Sahel	Seno	CHR Dori	1,369	15	18	1,369	0	888
C8	4713	CEmOC	Sud-Ouest	Poni	CHR de Gaoua	1,369	16	21	1,369	0	666
C12	1225	CEmOC	Centre-Nord	Bam	CMA de Kongoussi	1,131	17	12	1,131	0	1,131
C15	3627	CEmOC	Boucle du Mouhoun	Banwa	CMA de Solenzo	1,059	18	21	1,059	0	365
C5	3733	CEmOC	Boucle du Mouhoun	Sourou	CMA de Tougan	1,059	19	22	1,059	0	415
C10	720	CEmOC	Centre	Kadiogo	Clinique Kone Moussa	1,059	20	2	1,059	0	NR
C3	4026	CEmOC	Hauts-Bassins	Houet	Clinique Lorentia	1,059	21	2	1,059	0	384
C9	4007	CEmOC	Hauts-Bassins	Kenedougou	CMA de Orodara	1,059	22	17	1,059	0	309
C17	2328	CEmOC	Plateau Central	Ganzourgou	CMA de Zorgho	1,059	23	19	1,059	0	253
C6	4623	CEmOC	Sud-Ouest	Bougouriba	CMA de Diebougou	1,059	24	20	1,059	0	445
B1	1710	BEmOC	Centre-Est	Boulgou	CSPS de Zonse	636	25	17	636	0	553
					Total	49,796			49,796	0	42,091

Annex 15 – Region and Province level number and percentage of births where the household is located within 2 hours of travel time to a BEmOC (including CEmOC) when taking both travel time and coverage capacity into account

Region code [14]	Region Name [14]	Province code [14]	Province name [14]	Province level estimated nbr of birth in 2011 (using CBR from census 2006 [13] & Pop 2011 [10])	Region level estimated nbr of birth in 2011 (using CBR from census 2006 [13] & Pop 2011 [10])	Province level number of births located within 2 hours of travel to a BEmOC (including CEmOC) and for which there is enough capacity	Region level number of births located within 2 hours of travel to a BEmOC (including CEmOC) and for which there is enough capacity	Province level percentage of births located within 2 hours of travel to a BEmOC (including CEmOC) and for which there is enough capacity	Region level percentage of births located within 2 hours of travel to a BEmOC (including CEmOC) and for which there is enough capacity	Province level difference between the accessibility and geographic coverage	Region level difference between the accessibility and geographic coverage
BFA046	Boucle du Mouhoun	BFA046001	Bale	9,900	71,490	197	3,685	2.0%	5.2%	-59.4%	-54.6%
		BFA046002	Banwa	14,256		1,059		7.4%		-53.4%	
		BFA046003	Kossi	14,226		0		0.0%		-44.2%	
		BFA046004	Mouhoun	14,538		1,369		9.4%		-52.0%	
		BFA046005	Nayala	7,759		139		1.8%		-56.5%	
		BFA046006	Sourou	10,811		921		8.5%		-67.8%	
BFA047	Cascades	BFA047001	Comoe	20,857	27,340	1,776	1,776	8.5%	6.5%	-49.9%	-50.2%
		BFA047002	Leraba	6,482		0		0.0%		-51.3%	
BFA013	Centre	BFA013000	Kadiogo	69,973	69,973	14,373	14,373	20.5%	20.5%	-76.4%	-76.4%
BFA048	Centre-Est	BFA048001	Boulgou	28,234	58,834	477	3,182	1.7%	5.4%	-58.0%	-55.0%
		BFA048002	Koulpelogo	14,224		0		0.0%		-45.4%	
		BFA048003	Kouritenga	16,375		2,706		16.5%		-58.0%	
BFA049	Centre-Nord	BFA049001	Bam	13,904	64,276	1,131	3,021	8.1%	4.7%	-72.7%	-67.0%
		BFA049002	Namentenga	19,049		287		1.5%		-62.2%	
		BFA049003	Sanmatenga	31,322		1,603		5.1%		-67.3%	
BFA050	Centre-Ouest	BFA050001	Boulkiemde	23,656	58,471	1,976	1,976	8.4%	3.4%	-67.3%	-59.2%
		BFA050002	Sanguie	14,555		0		0.0%		-67.7%	
		BFA050003	Sissili	10,893		0		0.0%		-40.2%	
		BFA050004	Ziro	9,367		0		0.0%		-47.8%	
BFA051	Centre-Sud	BFA051001	Bazega	11,138	30,324	0	160	0.0%	0.5%	-47.9%	-57.1%
		BFA051002	Nahouri	7,081		0		0.0%		-61.4%	
		BFA051003	Zoundweogo	12,105		160		1.3%		-63.1%	
BFA052	Est	BFA052001	Gnagna	24,431	72,201	1,765	3,193	7.2%	4.4%	-46.5%	-31.7%
		BFA052002	Gourma	17,223		1,428		8.3%		-50.5%	
		BFA052003	Komonjdjari	4,718		0		0.0%		-25.9%	
		BFA052004	Kompienga	4,321		0		0.0%		-22.0%	
		BFA052005	Tapoa	21,507		0		0.0%		-3.1%	
BFA053	Hauts-Bassins	BFA053001	Houet	44,946	71,864	10,907	13,370	24.3%	18.6%	-44.1%	-43.2%
		BFA053002	Kenedougou	15,400		933		6.1%		-42.4%	
		BFA053003	Tuy	11,518		1,530		13.3%		-40.8%	
BFA054	Nord	BFA054001	Loroum	7,700	59,048	0	0	0.0%	0.00%	-29.7%	-55.5%
		BFA054002	Passore	15,346		0		0.0%		-63.3%	
		BFA054003	Yatenga	27,769		0		0.0%		-58.1%	
		BFA054004	Zondoma	8,234		0		0.0%		-56.1%	
BFA055	Plateau Central	BFA055001	Ganzourgou	16,589	35,121	1,261	1,262	7.6%	3.6%	-55.3%	-60.5%
		BFA055002	Kourweogo	6,442		0		0.0%		-66.7%	
		BFA055003	Oubritenga	12,090		0		0.0%		-64.2%	
BFA056	Sahel	BFA056001	Oudalan	9,389	51,557	0	1,369	0.0%	2.7%	-31.9%	-38.9%
		BFA056002	Seno	14,139		1,369		9.7%		-54.2%	
		BFA056003	Soum	18,873		0		0.0%		-41.2%	
		BFA056004	Yagha	9,156		0		0.0%		-17.5%	
BFA057	Sud-Ouest	BFA057001	Bougouriba	4,829	29,234	889	2,428	18.4%	8.3%	-53.7%	-54.2%
		BFA057002	Ioba	8,607		170		2.0%		-61.6%	
		BFA057003	Noumbiel	3,348		0		0.0%		-55.3%	
		BFA057004	Poni	12,450		1,369		11.0%		-49.1%	
		Country total/percentage:		699,735	699,735	49,795	49,795	7.1%	7.1%	-25.1%	

Annex 16 – Births referred to CEmOC for complication and corresponding number of EmOC surgical teams in CEmOC facilities

EmOC Code	EmOC name	Modeled number of births referred to CEmOC facilities for blood transfusion and/or C-section (5% of births at BEmOC level)	Number of births delivered by C-sections (MOH, 2012)	Expected number of EmOC surgical teams to cover the births refereed by the model (60 C-sections per year as the maximum workload per EmOC surgical team)	Expected number of EmOC surgical teams to cover the number of births delivered by C-section in 2012 (60 C-sections per year as the maximum workload per EmOC surgical team)	Estimated number of current EmOC team derived from the 2010 EmOC needs assessment	Gap in terms of number of EmOC surgical teams when considering the modeled number of referred births	Gap in terms of number EmOC surgical teams when considering the number of C-sections performed in 2012
C1	CMA de Do	228	306	3.8	5.1	5	-1.2	0.1
C2	CMA de Hounde	86	283	1.4	4.7	2	-0.6	2.7
C3	Clinique Lorentia	53	NA	0.9	NA	0	0.9	NA
C4	CHU Yalgado Ouedraogo	406	4382	6.8	73.0	6	0.8	67.0
C5	CMA de Tougan	53	160	0.9	2.7	2	-1.1	0.7
C6	CMA de Diebougou	53	110	0.9	1.8	2	-1.1	-0.2
C7	CHR Dori	68	204	1.1	3.4	3	-1.9	0.4
C8	CHR de Gaoua	68	277	1.1	4.6	1	0.1	3.6
C9	CMA de Orodara	53	348	0.9	5.8	2	-1.1	3.8
C10	Clinique Kone Moussa	53	NA	0.9	NA	2	-1.1	NA
C11	CMA du secteur 30	122	738	2.0	12.3	3	-1.0	9.3
C12	CMA de Kongoussi	57	139	0.9	2.3	2	-1.1	0.3
C13	CHR de Dedougou	68	270	1.1	4.5	2	-0.9	2.5
C14	CHR de Koudougou	99	653	1.6	10.9	3	-1.4	7.9
C15	CMA de Solenzo	53	421	0.9	7.0	2	-1.1	5.0
C16	CMA du secteur 26	138	NA	2.3	NA	0	2.3	NA
C17	CMA de Zorgho	230	367	3.8	6.1	3	0.8	3.1
C18	CHU Souro Sanou	265	944	4.4	15.7	6	-1.6	9.7
C19	CHR de Fada	174	344	2.9	5.7	3	-0.1	2.7
C20	CHR de Banfora	83	390	1.4	6.5	2	-0.6	4.5
C21	CHR de Kaya	80	424	1.3	7.1	2	-0.7	5.1
	Total	2,490		41.5		53	-11.5	128.3

Annex 17 – 105 facilities considered in the first scaling up scenario

EmOC Code	Fiche number	Facility Name	Facility Type	Total BEmOC signal functions	Total CEmOC signal functions	EmOC Type	Region Name	Province Name	Latitude	Longitude	Northing	Easting	Estimated maximum coverage capacity (Table 8)	Final coverage capacity	Processing order
C4	6402	CHU YALGADO OUEDRAOGO	CHU	7	2	Fully CEmOC	CENTRE	KADIOGO	12.37727	-1.51542	1368720.74033	661398.73799	5294	6201	1
C1	4123	CMA DE DO	CMA	7	2	Fully CEmOC	HAUTS-BASSINS	HOUET	11.20026	-4.29786	1238433.72186	358302.54147	1059	4553	2
C18	4420	CHU SOURO SANOU	CHR	7	2	Fully CEmOC	HAUTS-BASSINS	HOUET	11.17027	-4.30163	1235119.06606	357876.32198	1368	4388	3
B2	5706	CM DE POUYTENGA	CM	7	1	Fully BEmOC	CENTRE-EST	KOURITENGA	12.24874	-0.42666	1355393.56916	779958.39463	1842	2909	4
C16	24	CMA DU SECTEUR 26	CMA	7	2	Fully CEmOC	CENTRE	KADIOGO	12.36464	-1.53386	1367311.79108	659400.42038	1059	2753	5
C11	417	CMA DU SECTEUR 30	CMA	7	2	Fully CEmOC	CENTRE	KADIOGO	12.33865	-1.49546	1364460.67268	663592.58913	1059	2438	6
B4	2802	CSPS DE PIELA	CSPS	7	0	Fully BEmOC	EST	GNAGNA	12.71028	-0.13250	1406812.41043	811430.58658	636	2053	7
C14	1628	CHR DE KOUDOUGOU	CHR	7	2	Fully CEmOC	CENTRE-OUEST	BOULKIEMDE	12.25622	-2.35175	1354970.68180	570501.65212	1368	1976	8
B3	439	CENTRE MEDICAL SAINT CAMILLE	CM	7	0	Fully BEmOC	CENTRE	KADIOGO	12.38163	-1.50453	1369209.12897	662580.26325	1842	1922	9
C2	4215	CMA DE HOUNDE	CMA	7	2	Fully CEmOC	HAUTS-BASSINS	TUY	11.48827	-3.51782	1270019.38074	443526.11042	1059	1728	10
C20	3436	CHR DE BANFORA	CHR	7	2	Fully CEmOC	CASCADES	COMOE	10.63330	-4.75000	1175973.31296	308562.94327	1368	1650	11
C21	1135	CHR DE KAYA	CHR	7	2	Fully CEmOC	CENTRE-NORD	SANMATENGA	13.08333	-1.08333	1447138.30870	707811.40470	1368	1603	12
C19	2931	CHR DE FADA	CHR	7	2	Fully CEmOC	EST	GOURMA	12.05481	0.36097	1334858.20958	865991.18763	1368	1428	13
C8	4713	CHR DE GAOUA	CHR	7	2	Fully CEmOC	SUD-OUEST	PONI	10.32478	-3.17371	1141348.94562	480981.46713	1368	1368	14
C7	3222	CHR DORI	CHR	7	2	Fully CEmOC	SAHEL	SENO	14.02465	-0.02332	1552477.69161	821548.15294	1368	1368	15
C13	3807	CHR DE DEDOUGOU	CHR	7	2	Fully CEmOC	BOUCLE DU MOUHOUN	MOUHOUN	12.45460	-3.46362	1376867.20018	449616.72169	1368	1368	16
C12	1225	CMA DE KONGOUSSI	CMA	7	2	Fully CEmOC	CENTRE-NORD	BAM	13.33333	-1.53333	1474467.21466	658848.00243	1059	1131	17
C6	4623	CMA DE DIEBOUGOU	CMA	7	2	Fully CEmOC	SUD-OUEST	BOUGOURI	10.96667	-3.25000	1212305.09521	472685.89453	1059	1059	18
C17	2328	CMA DE ZORGHO	CMA	7	2	Fully CEmOC	PLATEAU-CENTRAL	GANZOURGOU	12.24712	-0.62814	1355013.49682	758028.33393	1059	1059	19
C3	4026	CLINIQUE LORENTIA	CMA	7	2	Fully CEmOC	HAUTS-BASSINS	HOUET	11.16956	-4.31003	1235044.73599	356958.58072	1059	1059	20
C9	4007	CMA DE ORODARA	CMA	7	2	Fully CEmOC	HAUTS-BASSINS	KENEDOUGOU	10.97378	-4.90816	1213741.39894	291491.09260	1059	1059	21
C10	720	CLINIQUE KONE MOUSSA	CMA	7	2	Fully CEmOC	CENTRE	KADIOGO	12.36663	-1.49787	1367554.31651	663313.12502	1059	1059	22
C15	3627	CMA DE SOLENZO	CMA	7	2	Fully CEmOC	BOUCLE DU MOUHOUN	BANWA	12.18330	-4.08330	1347057.87134	382146.78583	1059	1059	23
C5	3733	CMA DE TOUGAN	CMA	7	2	Fully CEmOC	BOUCLE DU MOUHOUN	SOUROU	13.06667	-3.06670	1444509.11196	492768.89519	1059	1059	24
B1	1710	CSPS DE ZONSE	CSPS	7	0	Fully BEmOC	CENTRE-EST	BOULGOU	11.35487	-0.63540	1256266.95891	758072.44671	636	636	25
CP20	4523	CMA DE DAFRA	CMA	6	2	Partially CEmOC	HAUTS-BASSINS	HOUET	11.19207	-4.25197	1237506.40867	363309.49672	1059	1939	26
BP2	5806	ESPACE MEDICAL DE SYA	CM	6	1	Partially BEmOC	HAUTS-BASSINS	HOUET	11.17033	-4.27415	1235113.05434	360876.80790	1842	1842	27
BP4	1817	CENTRE MEDICAL DE GARANGO	CM	6	0	Partially BEmOC	CENTRE-EST	BOULGOU	11.80433	-0.56600	1306070.32415	765226.18767	1842	1842	28
BP13	22	CENTRE MEDICAL LARRY EBERT	CM	6	0	Partially BEmOC	CENTRE	KADIOGO	12.39273	-1.45987	1370464.95526	667429.32173	1842	1842	29
BP16	140	CM AMA AGENCE MUSULMAN DAFRIQU	CM	6	0	Partially BEmOC	CENTRE	KADIOGO	12.37507	-1.45670	1368512.69647	667784.94081	1842	1842	30
BP32	717	CSPS DU SECTEUR 30	CSPS	6	0	Partially BEmOC	CENTRE	KADIOGO	12.33977	-1.47483	1364596.60706	665835.33732	636	1777	31
CP26	20	CMA SCHIPHRA	CMA	6	2	Partially CEmOC	CENTRE	KADIOGO	12.38785	-1.53000	1369881.78745	659806.47061	1059	1773	32
CP1	2723	CHR DE OUAHIGOUYA	CHR	6	2	Partially CEmOC	NORD	YATENGA	13.57340	-2.40770	1500625.02065	564080.18713	1368	1621	33
BP10	424	CSPS DU SECTEUR 15	CSPS	6	0	Partially BEmOC	CENTRE	KADIOGO	12.32473	-1.52158	1362905.21753	660760.20616	636	1590	34
CP6	2629	CMA DE YAKO	CMA	6	2	Partially CEmOC	NORD	PASSORE	12.95940	-2.27250	1432758.27455	578905.81508	1059	1531	35
CP3	1724	CHR DE TENKODOGO	CHR	6	2	Partially CEmOC	CENTRE-EST	BOULGOU	11.77543	-0.37300	1303061.82049	786299.94960	1368	1406	36
BP14	122	CSPS DE DASSASGHO SECTEUR 28	CSPS	6	0	Partially BEmOC	CENTRE	KADIO	12.39000	-1.47617	1370152.42942	665658.67563	636	1356	37
CP31	3217	CMA DE DJIBO	CMA	6	2	Partially CEmOC	SAHEL	SOUM	14.10367	-1.62443	1559625.83632	648494.37537	1059	1258	38
BP6	124	CSPS DE YAMTENGA	CSPS	6	0	Partially BEmOC	CENTRE	KADIOGO	12.34250	-1.45167	1364913.40747	668353.11929	636	1173	39
CP14	1937	CMA DE KOUPELA	CMA	6	2	Partially CEmOC	CENTRE-EST	KOURITENGA	12.17662	-0.35468	1347486.11688	787871.74674	1059	1159	40
CP8	2217	CMA DE ZINIARE	CMA	6	2	Partially CEmOC	PLATEAU-CENTRAL	OUBRITENGA	12.58583	-1.29247	1391937.70054	685494.46113	1059	1155	41
CP28	4818	CMA DE BATIE	CMA	6	2	Partially CEmOC	SUD-OUEST	NOMBIEL	9.87355	-2.91915	1091432.85915	508864.20395	1059	1059	42
CP4	3126	CMA DE GOROM GOROM	CMA	6	2	Partially CEmOC	SAHEL	OUDALAN	14.44181	-0.23765	1598380.54390	797831.65215	1059	1059	43
CP7	3104	CMA DE SEBBA	CMA	6	2	Partially CEmOC	SAHEL	YAGHA	13.43980	0.52082	1488498.07904	881334.25844	1059	1059	44
CP12	2709	CMA DE SEGUENEGA	CMA	6	2	Partially CEmOC	NORD	YATENGA	13.43738	-1.97050	1485736.88692	611446.60101	1059	1059	45
CP18	2406	CMA DE TITAO	CMA	6	2	Partially CEmOC	NORD	LOROUM	13.76907	-2.06870	1522381.25679	600675.38643	1059	1059	46
CP21	5402	CMA DE PAMA	CMA	6	2	Partially CEmOC	EST	KOMPIENGA	11.24761	0.70692	1245915.08379	904879.24033	1059	1059	47
CP9	2924	CMA DE DIAPAGA	CMA	6	2	Partially CEmOC	EST	TAPOA	12.06890	1.79093	1338743.20346	1021962.82433	1059	1059	48
CP25	838	CMA DE SAPONE	CMA	6	2	Partially CEmOC	CENTRE-SUD	BAZEGA	12.05243	-1.61433	1332732.50487	650826.70784	1059	1059	49
CP11	929	CMA DE KOMBISSIRI	CMA	6	2	Partially CEmOC	CENTRE-SUD	BAZEGA	12.07537	-1.34153	1335434.20460	680512.01948	1059	1059	50
CP24	808	CMA PO	CMA	6	2	Partially CEmOC	CENTRE-SUD	NAHOURI	11.17533	-1.13537	1236008.53488	703611.84415	1059	1059	51
CP19	5119	CMA DE MANGA 2 ECHELLON	CMA	6	2	Partially CEmOC	CENTRE-SUD	ZOUNDWEOGO	11.65645	-1.07128	1289280.21796	710257.18105	1059	1059	52
CP13	1432	CMA NANORO	CMA	6	2	Partially CEmOC	CENTRE-OUEST	BOULKIEMDE	12.68648	-2.18807	1402602.69858	588159.05063	1059	1059	53
CP15	1509	CMA LEO	CMA	6	2	Partially CEmOC	CENTRE-OUEST	SISSILI	11.10545	-2.10245	1227787.02018	598020.53078	1059	1059	54

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CP5	1001	CMA DE BOULSA	CMA	6	2	Partially CEmOC	CENTRE-NORD	NAMENTENGA	12.65795	-0.57158	1400535.62156	763768.66311	1059	1059	55
CP22	1208	CMA DE BARSALGO	CMA	6	2	Partially CEmOC	CENTRE-NORD	SANMATENGA	13.40698	-1.05352	1482973.53505	710766.49089	1059	1059	56
CP23	1732	CMA DE ZABRE	CMA	6	2	Partially CEmOC	CENTRE-EST	BOULGOU	11.17578	-0.62542	1236457.96843	759322.82127	1059	1059	57
CP10	2008	CMA DE OUARGAYE	CMA	6	2	Partially CEmOC	CENTRE-EST	KOULPELOGO	11.50298	0.05357	1273367.07490	833151.19692	1059	1059	58
CP29	18	POLYCLINIQUE NOTRE DAME PAIX	CMA	6	2	Partially CEmOC	CENTRE	KADIOGO	12.40850	-1.50167	1372183.12773	662874.44838	1059	1059	59
CP27	332	CLINIQUE EL FATEH SUKA	CMA	6	2	Partially CEmOC	CENTRE	KADIOGO	12.33500	-1.22257	1364238.31246	693275.92444	1059	1059	60
CP30	536	CLINIQUE MEDICALE CENTRE D'OR	CMA	6	2	Partially CEmOC	CENTRE	KADIOGO	12.32600	-1.52167	1363045.27909	660750.37094	1059	1059	61
CP16	3313	CMA DE SINDOU	CMA	6	2	Partially CEmOC	CASCADES	LERABA	10.65172	-5.18250	1178310.83574	261245.63492	1059	1059	62
CP17	5801	CMA DE BOROMO	CMA	6	2	Partially CEmOC	BOUCLE DU MOUHOUN	BALE	11.73793	-2.93933	1297575.79799	506610.43006	1059	1059	63
CP2	3520	CMA DE NOUNA	CMA	6	2	Partially CEmOC	BOUCLE DU MOUHOUN	KOSSI	12.72572	-3.85602	1406957.01150	407068.36141	1059	1059	64
BP21	1731	CSPS URBAIN	CSPS	6	0	Partially BEmOC	CENTRE-EST	KOURITENGA	12.17490	-0.35672	1347293.94645	787652.17905	636	978	65
BP15	137	CSPS TRAME D'ACCUEIL SECT 28	CSPS	6	0	Partially BEmOC	CENTRE	KADIOGO	12.38333	-1.45567	1369427.78604	667892.02265	636	926	66
BP8	4020	CSPS DE FARAKAN	CSPS	6	0	Partially BEmOC	HAUTS-BASSINS	HOUET	11.18668	-4.28995	1236928.81033	359159.24547	636	925	67
BP39	3229	CSPS DE SAMPELGA	CSPS	6	0	Partially BEmOC	SAHEL	SENO	13.75164	0.21784	1522584.27864	848029.85171	636	738	68
BP37	5303	CSPS DE KOMPIENGA	CSPS	6	0	Partially BEmOC	EST	KOMPIENGA	11.07932	0.72475	1227295.33553	907064.01085	636	727	69
BP36	2913	CSPS DE KANTCHARI	CSPS	6	0	Partially BEmOC	EST	TAPOA	12.47182	1.50723	1382897.74225	990245.20133	636	718	70
BP38	6105	CSPS DE FALANGOUNTOU	CSPS	6	0	Partially BEmOC	SAHEL	SENO	14.35766	0.18615	1589653.77886	843692.43895	636	683	71
BP7	418	CSPS DE KOUBRI = CSPS NAGBANGR	CSPS	6	0	Partially BEmOC	CENTRE	KADIOGO	12.18677	-1.40300	1347717.32571	673747.99799	636	670	72
BP26	6005	CSPS DE ESSAKANE	CSPS	6	0	Partially BEmOC	SAHEL	OUDALAN	14.36194	-0.03031	1589815.76277	820317.38433	636	636	73
BP31	6007	CSPS DE TASMAKAFF	CSPS	6	0	Partially BEmOC	SAHEL	OUDALAN	14.34032	-0.42000	1586916.81934	778284.38571	636	636	74
BP35	3128	CSPS DE BOUNDORE	CSPS	6	0	Partially BEmOC	SAHEL	YAGHA	13.44083	0.90833	1489246.30281	923359.43866	636	636	75
BP40	2318	CSPS DE MOGTEDO	CSPS	6	0	Partially BEmOC	PLATEAU-CENTRAL	GANZOURGOU	12.28579	-0.83473	1359103.20633	735509.65100	636	636	76
BP22	2434	CSPS DE SAMBA	CSPS	6	0	Partially BEmOC	NORD	PASSORE	12.68148	-2.37443	1401993.29821	567924.79514	636	636	77
BP23	2612	CSPS DE BINGO	CSPS	6	0	Partially BEmOC	NORD	YATENGA	13.57565	-2.40975	1500873.32553	563857.79148	636	636	78
BP11	4106	CSPS DE KOLOKO	CSPS	6	0	Partially BEmOC	HAUTS-BASSINS	KENEDOUGOU	11.07726	-5.30369	1225494.24053	248338.14859	636	636	79
BP9	4107	CSPS URBAIN	CSPS	6	0	Partially BEmOC	HAUTS-BASSINS	KENEDOUGOU	10.98583	-4.90325	1215071.39174	292036.02504	636	636	80
BP30	2816	CSPS DE TAPOA BARRAGE	CSPS	6	0	Partially BEmOC	EST	TAPOA	12.11977	1.76882	1344343.72675	1019451.34452	636	636	81
BP24	2825	CSPS DE TATIANGOU	CSPS	6	0	Partially BEmOC	EST	TAPOA	11.93548	1.38688	1323210.21621	978095.59172	636	636	82
BP25	2918	CSPS PRIVE MAHADAGA	CSPS	6	0	Partially BEmOC	EST	TAPOA	11.71937	1.75845	1299907.74772	1019081.59635	636	636	83
BP27	1026	CSPS DE BARGA	CSPS	6	0	Partially BEmOC	CENTRE-NORD	NAMENTENGA	13.64048	-0.74383	1509099.84799	744075.63706	636	636	84
BP17	1042	CSPS DE BONAM	CSPS	6	0	Partially BEmOC	CENTRE-NORD	NAMENTENGA	12.78750	-0.60590	1414867.78520	759454.82586	636	636	85
BP28	1047	CSPS DE KOGSABLOGO	CSPS	6	0	Partially BEmOC	CENTRE-NORD	NAMENTENGA	12.83627	-0.27497	1419456.89366	800343.74737	636	636	86
BP18	1709	CSPS DE DIARRA BETONGO	CSPS	6	0	Partially BEmOC	CENTRE-EST	BOULGOU	11.34927	-0.57166	1255704.69825	765038.23170	636	636	87
BP29	1811	CSPS DE ZOURMA	CSPS	6	0	Partially BEmOC	CENTRE-EST	BOULGOU	11.22145	-0.61922	1241516.93173	759959.46619	636	636	88
BP33	2006	CSPS DE DOURTENGA	CSPS	6	0	Partially BEmOC	CENTRE-EST	KOULPELOGO	11.58997	-0.00942	1282924.95276	826173.01473	636	636	89
BP19	1725	CSPS BASKOURE	CSPS	6	0	Partially BEmOC	CENTRE-EST	KOURITENGA	12.17670	-0.32025	1347473.08603	791621.87431	636	636	90
BP20	1729	CSPS DE NAKABA	CSPS	6	0	Partially BEmOC	CENTRE-EST	KOURITENGA	12.20172	-0.15345	1350486.51170	809757.37504	636	636	91
BP5	116	CSPS DE NONGTAABA	CSPS	6	0	Partially BEmOC	CENTRE	KADIOGO	12.28812	-1.47415	1358883.69077	665942.11110	636	636	92
BP34	718	CSPS DE NOOMWENDE	CSPS	6	0	Partially BEmOC	CENTRE	KADIOGO	12.32130	-1.47018	1362556.76631	666352.70386	636	636	93
BP3	4406	CMA DE DANDE	CMA	6	1	Partially BEmOC	HAUTS-BASSINS	HOUET	11.56848	-4.54027	1278842.46616	332136.91930	285	371	94
BP12	2132	CMA DE BOUSSE	CMA	6	0	Partially BEmOC	PLATEAU-CENTRAL	KOURWEOGO	12.65480	-1.88823	1399218.49548	620732.87498	285	296	95
BP1	5404	CMA DE GAYIRI	CMA	6	1	Partially BEmOC	EST	KOMONDJARI	12.65039	0.48951	1401004.76535	879143.38125	285	285	96
CP34	237	CMA DE PAUL VI	CMA	5	2	Partially CEmOC	CENTRE	KADIOGO	12.39282	-1.55372	1370417.08495	657224.70609	1059	3067	97
CP32	4634	CMA DE DANO	CMA	5	2	Partially CEmOC	SUD-OUEST	IOBA	11.14165	-3.07132	1231642.74976	492212.79854	1059	1059	98
CP33	2907	CMA DE BOGANDE	CMA	5	2	Partially CEmOC	EST	GNAGNA	12.97081	-0.14375	1435642.59576	809888.22969	1059	1059	99
CP35	525	CLINIQUE SAINT JEREMIE	CMA	5	2	Partially CEmOC	CENTRE	KADIOGO	12.30703	-1.48522	1360969.37317	664726.52486	1059	1059	100
CP36	620	CMA DE PISSY	CMA	4	2	Partially CEmOC	CENTRE	KADIOGO	12.33500	-1.56860	1364013.11459	655640.65462	1059	4632	101
CP40	109	POLYCLINIQUE YENTEMA	CMA	4	2	Partially CEmOC	CENTRE	KADIOGO	12.35917	-1.52650	1366711.09331	660204.52744	1059	1059	102
CP38	125	CLINIQUE KOMBASSE	CMA	4	2	Partially CEmOC	CENTRE	KADIOGO	12.35300	-1.48700	1366052.92748	664503.87435	1059	1059	103
CP37	438	CLINIQUE LES GENETS	CMA	4	2	Partially CEmOC	CENTRE	KADIOGO	12.30873	-1.50700	1361144.15948	662356.13683	1059	1059	104
CP39	6601	CLINIQUE SAINT MARC	CMA	4	2	Partially CEmOC	CENTRE	KADIOGO	12.37000	-1.49033	1367931.35411	664130.76471	1059	1059	105

Total 134,134

Annex 18 – Health facility level results for the first scaling up scenario

EmOC code	Fiche number	Facility name	Facility type	EmOC type	Number of assisted deliveries (MOH, 2012)	AccessMod processing order	Travel time at the catchment area border (min)	Births covered by the first scenario	Equivalent number of skilled birth attendants needed to cover the demand (benchmark from Section 6.3)	Real number of skilled birth attendants (MOH, 2012)	Gap in terms of skilled births attendants to comply with the result of the first secnario
C4	6402	CHU YALGADO OUEDRAOGO	CHU	Fully CEmOC	6201	1	120	155,433	888.2	272	616
C1	4123	CMA DE DO	CMA	Fully CEmOC	4553	2	120	57,860	578.6	68	511
C18	4420	CHU SOURO SANOU	CHR	Fully CEmOC	4388	3	120	298	1.7	284	-282
B2	5706	CM DE POUYTENGA	CM	Fully BEmOC	2909	4	120	47,655	635.4	45	590
C16	24	CMA DU SECTEUR 26	CMA	Fully CEmOC	2753	5	120	846	8.5	46	-38
C11	417	CMA DU SECTEUR 30	CMA	Fully CEmOC	2438	6	120	663	6.6	107	-100
B4	2802	CSPS DE PIELA	CSPS	Fully BEmOC	2053	7	120	10,755	143.4	9	134
C14	1628	CHR DE KOUDOUGOU	CHR	Fully CEmOC	1976	8	120	22,984	131.3	117	14
B3	439	CENTRE MEDICAL SAINT CAMILLE	CM	Fully BEmOC	1922	9	120	271	3.6	64	-60
C2	4215	CMA DE HOUNDE	CMA	Fully CEmOC	1728	10	120	11,526	115.3	48	67
C20	3436	CHR DE BANFORA	CHR	Fully CEmOC	1650	11	120	6,122	35.0	98	-63
C21	1135	CHR DE KAYA	CHR	Fully CEmOC	1603	12	120	16,216	92.7	88	5
C19	2931	CHR DE FADA	CHR	Fully CEmOC	1428	13	120	7,969	45.5	105	-59
C8	4713	CHR DE GAOUA	CHR	Fully CEmOC	666	14	120	10,365	59.2	36	23
C7	3222	CHR DORI	CHR	Fully CEmOC	888	15	120	14,542	83.1	71	12
C13	3807	CHR DE DEDOUGOU	CHR	Fully CEmOC	1080	16	120	17,194	98.3	64	34
C12	1225	CMA DE KONGOUSSI	CMA	Fully CEmOC	1131	17	120	21,558	215.6	60	156
C6	4623	CMA DE DIEBOUGOU	CMA	Fully CEmOC	445	18	120	3,633	36.3	47	-11
C17	2328	CMA DE ZORGHO	CMA	Fully CEmOC	253	19	120	636	6.4	46	-40
C3	4026	CLINIQUE LORENTIA	CMA	Fully CEmOC	384	20	120	16	0.2	7	-7
C9	4007	CMA DE ORODARA	CMA	Fully CEmOC	309	21	120	1,153	11.5	30	-18
C10	720	CLINIQUE KONE MOUSSA	CMA	Fully CEmOC	NA	22	120	0	0.0	31	-31
C15	3627	CMA DE SOLENZO	CMA	Fully CEmOC	365	23	120	1,526	15.3	56	-41
C5	3733	CMA DE TOUGAN	CMA	Fully CEmOC	415	24	120	7,801	78.0	48	30
B1	1710	CSPS DE ZONSE	CSPS	Fully BEmOC	553	25	120	10,888	145.2	3	142
CP20	4523	CMA DE DAFRA	CMA	Partially CEmOC	1939	26	120	4	0.0	55	-55
BP2	5806	ESPACE MEDICAL DE SYA	CM	Partially BEmOC	NA	27	120	28	0.4	8	-8
BP4	1817	CENTRE MEDICAL DE GARANGO	CM	Partially BEmOC	696	28	120	2,595	34.6	25	10
BP13	22	CENTRE MEDICAL LARRY EBERT	CM	Partially BEmOC	NA	29	120	48	0.6	11	-10
BP16	140	CM AMA AGENCE MUSULMAN DAFRIQU	CM	Partially BEmOC	NA	30	120	0	0.0	22	-22
BP32	717	CSPS DU SECTEUR 30	CSPS	Partially BEmOC	1777	31	120	9	0.1	29	-29
CP26	20	CMA SCHIPHRA	CMA	Partially CEmOC	1773	32	120	7	0.1	57	-57
CP1	2723	CHR DE OUAHIGOUYA	CHR	Partially CEmOC	1621	33	120	9,044	51.7	83	-31
BP10	424	CSPS DU SECTEUR 15	CSPS	Partially BEmOC	1590	34	120	67	0.9	32	-31
CP6	2629	CMA DE YAKO	CMA	Partially CEmOC	1531	35	120	1,693	16.9	43	-26
CP3	1724	CHR DE TENKODOGO	CHR	Partially CEmOC	1406	36	120	1,684	9.6	89	-79
BP14	122	CSPS DE DASSASGHO SECTEUR 28	CSPS	Partially BEmOC	1356	37	120	22	0.3	31	-31
CP31	3217	CMA DE DJIBO	CMA	Partially CEmOC	1258	38	120	2,772	27.7	41	-13
BP6	124	CSPS DE YAMTENGA	CSPS	Partially BEmOC	1173	39	120	0	0.0	20	-20
CP14	1937	CMA DE KOUPELA	CMA	Partially CEmOC	1159	40	120	173	1.7	49	-47
CP8	2217	CMA DE ZINIARE	CMA	Partially CEmOC	1155	41	120	448	4.5	79	-75
CP28	4818	CMA DE BATIE	CMA	Partially CEmOC	675	42	120	249	2.5	47	-45
CP4	3126	CMA DE GOROM GOROM	CMA	Partially CEmOC	381	43	120	1,474	14.7	24	-9
CP7	3104	CMA DE SEBBA	CMA	Partially CEmOC	NA	44	120	2,734	27.3	18	9
CP12	2709	CMA DE SEGUENEGA	CMA	Partially CEmOC	325	45	120	241	2.4	25	-23
CP18	2406	CMA DE TITAO	CMA	Partially CEmOC	325	46	120	390	3.9	38	-34
CP21	5402	CMA DE PAMA	CMA	Partially CEmOC	471	47	120	2,644	26.4	29	-3

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CP9	2924	CMA DE DIAPAGA	CMA	Partially CEmOC	404	48	120	9,006	90.1	29	61
CP25	838	CMA DE SAPONE	CMA	Partially CEmOC	271	49	120	751	7.5	28	-20
CP11	929	CMA DE KOMBISSIRI	CMA	Partially CEmOC	313	50	120	860	8.6	15	-6
CP24	808	CMA PO	CMA	Partially CEmOC	454	51	120	835	8.3	34	-26
CP19	5119	CMA DE MANGA 2 ECHELLON	CMA	Partially CEmOC	1035	52	120	628	6.3	37	-31
CP13	1432	CMA NANORO	CMA	Partially CEmOC	558	53	120	398	4.0	46	-42
CP15	1509	CMA LEO	CMA	Partially CEmOC	335	54	120	1,946	19.5	34	-15
CP5	1001	CMA DE BOULSA	CMA	Partially CEmOC	1056	55	120	769	7.7	56	-48
CP22	1208	CMA DE BARSALGO	CMA	Partially CEmOC	833	56	120	899	9.0	41	-32
CP23	1732	CMA DE ZABRE	CMA	Partially CEmOC	401	57	120	406	4.1	31	-27
CP10	2008	CMA DE OUARGAYE	CMA	Partially CEmOC	458	58	120	1,307	13.1	20	-7
CP29	18	POLYCLINIQUE NOTRE DAME PAIX	CMA	Partially CEmOC	NA	59	120	0	0.0	19	-19
CP27	332	CLINIQUE EL FATEH SUKA	CMA	Partially CEmOC	NA	60	120	51	0.5	32	-31
CP30	536	CLINIQUE MEDICALE CENTRE D'OR	CMA	Partially CEmOC	NA	61	120	0	0.0	18	-18
CP16	3313	CMA DE SINDOU	CMA	Partially CEmOC	560	62	120	161	1.6	16	-14
CP17	5801	CMA DE BOROMO	CMA	Partially CEmOC	630	63	120	893	8.9	61	-52
CP2	3520	CMA DE NOUNA	CMA	Partially CEmOC	839	64	120	2,458	24.6	69	-44
BP21	1731	CSPS URBAIN	CSPS	Partially BEmOC	978	65	120	0	0.0	21	-21
BP15	137	CSPS TRAME D'ACCUEIL SECT 28	CSPS	Partially BEmOC	926	66	120	0	0.0	24	-24
BP8	4020	CSPS DE FARAKAN	CSPS	Partially BEmOC	925	67	120	0	0.0	21	-21
BP39	3229	CSPS DE SAMPELGA	CSPS	Partially BEmOC	738	68	120	168	2.2	7	-5
BP37	5303	CSPS DE KOMPIENGA	CSPS	Partially BEmOC	727	69	120	56	0.8	9	-8
BP36	2913	CSPS DE KANTCHARI	CSPS	Partially BEmOC	718	70	120	1,117	14.9	8	7
BP38	6105	CSPS DE FALANGOUNTOU	CSPS	Partially BEmOC	683	71	120	338	4.5	6	-1
BP7	418	CSPS DE KOUBRI = CSPS NAGBANGR	CSPS	Partially BEmOC	670	72	120	25	0.3	12	-12
BP26	6005	CSPS DE ESSAKANE	CSPS	Partially BEmOC	379	73	120	10	0.1	3	-3
BP31	6007	CSPS DE TASMAKAFF	CSPS	Partially BEmOC	340	74	120	591	7.9	5	3
BP35	3128	CSPS DE BOUNDORE	CSPS	Partially BEmOC	603	75	120	299	4.0	1	3
BP40	2318	CSPS DE MOGTEDO	CSPS	Partially BEmOC	458	76	120	133	1.8	11	-9
BP22	2434	CSPS DE SAMBA	CSPS	Partially BEmOC	408	77	120	314	4.2	5	-1
BP23	2612	CSPS DE BINGO	CSPS	Partially BEmOC	252	78	120	0	0.0	27	-27
BP11	4106	CSPS DE KOLOKO	CSPS	Partially BEmOC	361	79	120	193	2.6	5	-2
BP9	4107	CSPS URBAIN	CSPS	Partially BEmOC	309	80	120	0	0.0	10	-10
BP30	2816	CSPS DE TAPOA BARRAGE	CSPS	Partially BEmOC	217	81	120	189	2.5	2	1
BP24	2825	CSPS DE TATIANGOU	CSPS	Partially BEmOC	438	82	120	176	2.3	4	-2
BP25	2918	CSPS PRIVE MAHADAGA	CSPS	Partially BEmOC	349	83	120	315	4.2	8	-4
BP27	1026	CSPS DE BARGA	CSPS	Partially BEmOC	123	84	120	37	0.5	2	-2
BP17	1042	CSPS DE BONAM	CSPS	Partially BEmOC	321	85	120	189	2.5	3	0
BP28	1047	CSPS DE KOGSABLOGO	CSPS	Partially BEmOC	431	86	120	42	0.6	2	-1
BP18	1709	CSPS DE DIARRA BETONGO	CSPS	Partially BEmOC	NA	87	120	5	0.1	3	-3
BP29	1811	CSPS DE ZOURMA	CSPS	Partially BEmOC	358	88	120	73	1.0	2	-1
BP33	2006	CSPS DE DOURTENGA	CSPS	Partially BEmOC	331	89	120	115	1.5	2	0
BP19	1725	CSPS BASKOURE	CSPS	Partially BEmOC	341	90	120	32	0.4	3	-3
BP20	1729	CSPS DE NAKABA	CSPS	Partially BEmOC	183	91	120	82	1.1	2	-1
BP5	116	CSPS DE NONGTAABA	CSPS	Partially BEmOC	270	92	120	8	0.1	14	-14
BP34	718	CSPS DE NOOMWENDE	CSPS	Partially BEmOC	291	93	120	0	0.0	8	-8
BP3	4406	CMA DE DANDE	CMA	Partially BEmOC	371	94	120	1,639	16.4	27	-11
BP12	2132	CMA DE BOUSSE	CMA	Partially BEmOC	296	95	120	392	3.9	27	-23
BP1	5404	CMA DE GAYIRI	CMA	Partially BEmOC	189	96	120	878	8.8	8	1
CP34	237	CMA DE PAUL VI	CMA	Partially CEmOC	3067	97	120	68	0.7	71	-70
CP32	4634	CMA DE DANO	CMA	Partially CEmOC	367	98	120	517	5.2	33	-28
CP33	2907	CMA DE BOGANDE	CMA	Partially CEmOC	383	99	120	542	5.4	35	-30
CP35	525	CLINIQUE SAINT JEREMIE	CMA	Partially CEmOC	NA	100	120	0	0.0	13	-13
CP36	620	CMA DE PISSY	CMA	Partially CEmOC	4632	101	120	71	0.7	71	-70
CP40	109	POLYCLINIQUE YENTEMA	CMA	Partially CEmOC	NA	102	120	0	0.0	35	-35
CP38	125	CLINIQUE KOMBASSE	CMA	Partially CEmOC	NA	103	120	0	0.0	8	-8
CP37	438	CLINIQUE LES GENETS	CMA	Partially CEmOC	NA	104	120	0	0.0	16	-16
CP39	6601	CLINIQUE SAINT MARC	CMA	Partially CEmOC	NA	105	120	0	0.0	10	-10

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		Total	484,218	3,976.1	3,875.0	102

0.692002535	sum of blue cells (surplus)	-2,327	82
	sum of white cells (gap)	2,429	21

Annex 19 – Health facility level results for the second scaling up scenario (first variant)

EmOC code	Fiche number	Facility name	Facility type	EmOC type	Number of assisted deliveries (MOH, 2012)	AccessMod processing order followed for both steps	Births covered in 2 hours travel time	Births that would reach the waiting home between 2 and 6 hours of travel time	Total number of births to be coverted by the BEmOC facility	Equivalent number of skilled birth attendants needed to cover the demand (benchmark from Section 6.3)	Real number of skilled birth attendants (MOH, 2012)	Gap in terms of skilled births attendants to comply with the result of the first secnario
C4	6402	CHU YALGADO OUEDRAOGO	CHU	Fully CEmOC	6201	1	155,082	137,899	292,980	1674.2	272	1,402
C1	4123	CMA DE DO	CMA	Fully CEmOC	4553	2	645	173	818	8.2	68	-60
C18	4420	CHU SOURO SANOU	CHR	Fully CEmOC	4388	3	57,514	35,405	92,919	531.0	284	247
B2	5706	CM DE POUYTENGA	CM	Fully BEmOC	2909	4	47,605	18,518	66,122	881.6	45	837
C16	24	CMA DU SECTEUR 26	CMA	Fully CEmOC	2753	5	846	231	1,077	10.8	46	-35
C11	417	CMA DU SECTEUR 30	CMA	Fully CEmOC	2438	6	660	122	782	7.8	107	-99
B4	2802	CSPS DE PIELA	CSPS	Fully BEmOC	2053	7	10,755	4,558	15,313	153.1	9	144
C14	1628	CHR DE KOUDOUGOU	CHR	Fully CEmOC	1976	8	22,984	3,783	26,767	153.0	117	36
B3	439	CENTRE MEDICAL SAINT CAMILLE	CM	Fully BEmOC	1922	9	274	20	294	3.9	64	-60
C2	4215	CMA DE HOUNDE	CMA	Fully CEmOC	1728	10	11,526	2,016	13,542	135.4	48	87
C20	3436	CHR DE BANFORA	CHR	Fully CEmOC	1650	11	6,122	1,325	7,447	42.6	98	-55
C21	1135	CHR DE KAYA	CHR	Fully CEmOC	1603	12	16,216	2,870	19,086	109.1	88	21
C19	2931	CHR DE FADA	CHR	Fully CEmOC	1428	13	7,959	3,479	11,437	65.4	105	-40
C8	4713	CHR DE GAOUA	CHR	Fully CEmOC	666	14	10,365	2,063	12,428	71.0	36	35
C7	3222	CHR DORI	CHR	Fully CEmOC	888	15	14,542	3,404	17,946	102.6	71	32
C13	3807	CHR DE DEDOUGOU	CHR	Fully CEmOC	1080	16	17,194	2,842	20,036	114.5	64	50
C12	1225	CMA DE KONGOUSSI	CMA	Fully CEmOC	1131	17	21,558	1,274	22,832	228.3	60	168
C6	4623	CMA DE DIEBOUGOU	CMA	Fully CEmOC	445	18	3,633	438	4,071	40.7	47	-6
C17	2328	CMA DE ZORGHO	CMA	Fully CEmOC	253	19	636	114	751	7.5	46	-38
C3	4026	CLINIQUE LORENTIA	CMA	Fully CEmOC	384	20	16	6	22	0.2	7	-7
C9	4007	CMA DE ORODARA	CMA	Fully CEmOC	309	21	1,153	560	1,713	17.1	30	-13
C10	720	CLINIQUE KONE MOUSSA	CMA	Fully CEmOC	NA	22	0	0	0	0.0	31	-31
C15	3627	CMA DE SOLENZO	CMA	Fully CEmOC	365	23	1,526	467	1,994	19.9	56	-36
C5	3733	CMA DE TOUGAN	CMA	Fully CEmOC	415	24	7,801	461	8,263	82.6	48	35
B1	1710	CSPS DE ZONSE	CSPS	Fully BEmOC	553	25	10,532	641	11,174	111.7	3	109

| | | | | | | | 427,144 | 222,670 | 649,814 | 4,572.2 | 1,850.0 | 2,723 |

0.928657544

sum of blue cells (surplus)	-480	12 number of facilitie
sum of white cells (gap)	3,203	13 number of facilitie

Annex 20 – Births referred to CEmOC for complication and corresponding number of EmOC surgical teams in CEmOC facilities for the second scaling up scenario (first variant)

EmOC Code	Fiche number	EmOC name	Modeled number of births referred to CEmOC facilities for blood transfusion and/or C-section (5% of births at BEmOC level)	Number of births delivered by C-sections (MOH, 2012)	Expected number of EmOC surgical teams to cover the referred births (60 C-sections per year as the maximum workload per EmOC surgical team)	Expected number of EmOC surgical teams to cover the number of births delivered by C-section in 2012 (60 C-sections per year as the maximum workload per EmOC surgical team)	Estimated number of current EmOC team derived from the 2010 EmOC needs assessment	Gap in terms of number of EmOC surgical teams when considering the modeled number of referred births	Gap in terms of number EmOC surgical teams when considering the number of C-sections performed in 2012
C1	4123	CMA de Do	41	306	0.7	5.1	5	-4.3	0.1
C2	4215	CMA de Hounde	677	283	11.3	4.7	2	9.3	2.7
C3	4026	Clinique Lorentia	1	NA	0.0	NA	0	0.0	NA
C4	6402	CHU Yalgado Ouedraogo	14664	4382	244.4	73.0	6	238.4	67.0
C5	3733	CMA de Tougan	413	160	6.9	2.7	2	4.9	0.7
C6	4623	CMA de Diebougou	204	110	3.4	1.8	2	1.4	-0.2
C7	3222	CHR Dori	897	204	15.0	3.4	3	12.0	0.4
C8	4713	CHR de Gaoua	621	277	10.4	4.6	1	9.4	3.6
C9	4007	CMA de Orodara	86	348	1.4	5.8	2	-0.6	3.8
C10	720	Clinique Kone Moussa	0	NA	0.0	NA	2	-2.0	NA
C11	417	CMA du secteur 30	39	738	0.7	12.3	3	-2.3	9.3
C12	1225	CMA de Kongoussi	1142	139	19.0	2.3	2	17.0	0.3
C13	3807	CHR de Dedougou	1002	270	16.7	4.5	2	14.7	2.5
C14	1628	CHR de Koudougou	1338	653	22.3	10.9	3	19.3	7.9
C15	3627	CMA de Solenzo	100	421	1.7	7.0	2	-0.3	5.0
C16	24	CMA du secteur 26	54	NA	0.9	NA	0	0.9	NA
C17	2328	CMA de Zorgho	3902	367	65.0	6.1	3	62.0	3.1
C18	4420	CHU Souro Sanou	4646	944	77.4	15.7	6	71.4	9.7
C19	2931	CHR de Fada	1338	344	22.3	5.7	3	19.3	2.7
C20	3436	CHR de Banfora	372	390	6.2	6.5	2	4.2	4.5
C21	1135	CHR de Kaya	954	424	15.9	7.1	2	13.9	5.1
		Total	32490		541.5		53	488.5	

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Annex 21 – Regional and Province level number and percentage of births covered with the second scaling up scenario (first variant)

Region code [14]	Region Name [14]	Province code [14]	Province name [14]	Province level estimated nbr of birth in 2011 (using CBR from census 2006 [13] & Pop 2011 [10])	Region level estimated nbr of birth in 2011 (using CBR from census 2006 [13] & Pop 2011 [10])	Province level number of births covered by the second scaling up scenario	Region level number of births covered by the second scaling up scenario	Province level percentage of births covered by the second scaling up scenario	Region level percentage of births covered by the second scaling up scenario
BFA046	Boucle du Mouhoun	BFA046001	Bale	9,900	71,490	9,372	67,564	94.7%	94.5%
		BFA046002	Banwa	14,256		12,914		90.6%	
		BFA046003	Kossi	14,226		13,670		96.1%	
		BFA046004	Mouhoun	14,538		13,438		92.4%	
		BFA046005	Nayala	7,759		7,409		95.5%	
		BFA046006	Sourou	10,811		10,760		99.5%	
BFA047	Cascades	BFA047001	Comoe	20,857	27,340	17,757	23,587	85.1%	86.3%
		BFA047002	Leraba	6,482		5,830		89.9%	
BFA013	Centre	BFA013000	Kadiogo	69,973	69,973	69,374	69,374	99.1%	99.1%
BFA048	Centre-Est	BFA048001	Boulgou	28,234	58,834	26,269	55,220	93.0%	93.9%
		BFA048002	Koulpelogo	14,224		12,680		89.1%	
		BFA048003	Kouritenga	16,375		16,270		99.4%	
BFA049	Centre-Nord	BFA049001	Bam	13,904	64,276	13,890	63,551	99.9%	98.9%
		BFA049002	Namentenga	19,049		18,591		97.6%	
		BFA049003	Sanmatenga	31,322		31,070		99.2%	
BFA050	Centre-Ouest	BFA050001	Boulkiemde	23,656	58,471	23,553	55,038	99.6%	94.1%
		BFA050002	Sanguie	14,555		13,946		95.8%	
		BFA050003	Sissili	10,893		9,624		88.3%	
		BFA050004	Ziro	9,367		7,915		84.5%	
BFA051	Centre-Sud	BFA051001	Bazega	11,138	30,324	10,014	27,849	89.9%	91.8%
		BFA051002	Nahouri	7,081		6,485		91.6%	
		BFA051003	Zoundweogo	12,105		11,349		93.8%	
BFA052	Est	BFA052001	Gnagna	24,431	72,201	22,655	59,133	92.7%	81.9%
		BFA052002	Gourma	17,223		14,833		86.1%	
		BFA052003	Komonjdjari	4,718		3,866		81.9%	
		BFA052004	Kompienga	4,321		2,575		59.6%	
		BFA052005	Tapoa	21,507		15,203		70.7%	
BFA053	Hauts-Bassins	BFA053001	Houet	44,946	71,864	40,048	64,018	89.1%	89.1%
		BFA053002	Kenedougou	15,400		13,822		89.8%	
		BFA053003	Tuy	11,518		10,148		88.1%	
BFA054	Nord	BFA054001	Loroum	7,700	59,048	7,294	57,780	94.7%	97.9%
		BFA054002	Passore	15,346		14,835		96.7%	
		BFA054003	Yatenga	27,769		27,429		98.8%	
		BFA054004	Zondoma	8,234		8,222		99.9%	
BFA055	Plateau Central	BFA055001	Ganzourgou	16,589	35,121	15,771	33,776	95.1%	96.2%
		BFA055002	Kourweogo	6,442		6,398		99.3%	
		BFA055003	Oubritenga	12,090		11,607		96.0%	
BFA056	Sahel	BFA056001	Oudalan	9,389	51,557	7,659	45,793	81.6%	88.8%
		BFA056002	Seno	14,139		13,702		96.9%	
		BFA056003	Soum	18,873		17,316		91.8%	
		BFA056004	Yagha	9,156		7,115		77.7%	
BFA057	Sud-Ouest	BFA057001	Bougouriba	4,829	29,234	4,608	27,131	95.4%	92.8%
		BFA057002	Ioba	8,607		8,194		95.2%	
		BFA057003	Noumbiel	3,348		3,024		90.3%	
		BFA057004	Poni	12,450		11,305		90.8%	

			Country total/percentage:	699,735	699,735	649,814	649,814	92.9%	92.9%

Color legend:

Values obtained with AccessMod
Calculated variables

Annex 22 – Health facility level results for the second scaling up scenario (second variant)

EmOC code	Fiche number	Facility name	Facility type	EmOC type	Number of assisted deliveries (MOH, 2012)	AccessMod processing order followed for the first step	Births covered in 2 hours travel time	Births that would reach the waiting home between 2 and 6 hours of travel time	Total number of births to be coverted by the BEmOC facility	Equivalent number of skilled birth attendants needed to cover the demand (benchmark from Section 6.3)	Real number of skilled birth attendants (MOH, 2012)	Gap in terms of skilled births attendants to comply with the result of the first secnario
C4	6402	CHU YALGADO OUEDRAOGO	CHU	Fully CEmOC	6201	1	155,082	1,644	156,725	895.6	272	624
C1	4123	CMA DE DO	CMA	Fully CEmOC	4553	2	645	6,182	6,827	68.3	68	0
C18	4420	CHU SOURO SANOU	CHR	Fully CEmOC	4388	3	57,514	2,017	59,530	340.2	284	56
B2	5706	CM DE POUYTENGA	CM	Fully BEmOC	2909	4	47,605	8,563	56,168	748.9	45	704
C16	24	CMA DU SECTEUR 26	CMA	Fully CEmOC	2753	5	846	3,992	4,838	48.4	46	2
C11	417	CMA DU SECTEUR 30	CMA	Fully CEmOC	2438	6	660	7,375	8,035	80.4	107	-27
B4	2802	CSPS DE PIELA	CSPS	Fully BEmOC	2053	7	10,755	11,804	22,560	225.6	9	217
C14	1628	CHR DE KOUDOUGOU	CHR	Fully CEmOC	1976	8	22,984	16,484	39,469	225.5	117	109
B3	439	CENTRE MEDICAL SAINT CAMILLE	CM	Fully BEmOC	1922	9	274	2,154	2,428	32.4	64	-32
C2	4215	CMA DE HOUNDE	CMA	Fully CEmOC	1728	10	11,526	7,396	18,923	189.2	48	141
C20	3436	CHR DE BANFORA	CHR	Fully CEmOC	1650	11	6,122	6,440	12,562	71.8	98	-26
C21	1135	CHR DE KAYA	CHR	Fully CEmOC	1603	12	16,216	11,468	27,684	158.2	88	70
C19	2931	CHR DE FADA	CHR	Fully CEmOC	1428	13	7,959	29,778	37,737	215.6	105	111
C8	4713	CHR DE GAOUA	CHR	Fully CEmOC	666	14	10,365	5,869	16,234	92.8	36	57
C7	3222	CHR DORI	CHR	Fully CEmOC	888	15	14,542	18,153	32,695	186.8	71	116
C13	3807	CHR DE DEDOUGOU	CHR	Fully CEmOC	1080	16	17,194	11,303	28,497	162.8	64	99
C12	1225	CMA DE KONGOUSSI	CMA	Fully CEmOC	1131	17	21,558	18,970	40,527	405.3	60	345
C6	4623	CMA DE DIEBOUGOU	CMA	Fully CEmOC	445	18	3,633	6,704	10,338	103.4	47	56
C17	2328	CMA DE ZORGHO	CMA	Fully CEmOC	253	19	636	5,161	5,797	58.0	46	12
C3	4026	CLINIQUE LORENTIA	CMA	Fully CEmOC	384	20	16	2,187	2,203	22.0	7	15
C9	4007	CMA DE ORODARA	CMA	Fully CEmOC	309	21	1,153	5,089	6,241	62.4	30	32
C10	720	CLINIQUE KONE MOUSSA	CMA	Fully CEmOC	NA	22	0	664	664	6.6	31	-24
C15	3627	CMA DE SOLENZO	CMA	Fully CEmOC	365	23	1,526	5,715	7,241	72.4	56	16
C5	3733	CMA DE TOUGAN	CMA	Fully CEmOC	415	24	7,801	16,162	23,963	239.6	48	192
B1	1710	CSPS DE ZONSE	CSPS	Fully BEmOC	553	25	10,532	11,396	21,928	219.3	3	216
							427,144	222,670	649,814	4,931.5	1,850.0	3,081

sum of blue cells (surplus)	-109
sum of white cells (gap)	3,190

Annex 23 – Births referred to CEmOC for complication and corresponding number of EmOC surgical teams in CEmOC facilities for the second scaling up scenario (second variant)

EmOC Code	Fiche number	EmOC name	Modeled number of births referred to CEmOC facilities for blood transfusion and/or C-section (5% of births at BEmOC level)	Number of births delivered by C-sections (MOH, 2012)	Expected number of EmOC surgical teams to cover the referred births (60 C-sections per year as the maximum workload per EmOC surgical team)	Expected number of EmOC surgical teams to cover the number of births delivered by C-section in 2012 (60 C-sections per year as the maximum workload per EmOC surgical team)	Estimated number of current EmOC team derived from the 2010 EmOC needs assessment	Gap in terms of number of EmOC surgical teams when considering the modeled number of referred births	Gap in terms of number EmOC surgical teams when considering the number of C-sections performed in 2012
C1	4123	CMA de Do	341	306	5.7	5.1	5	0.7	0.1
C2	4215	CMA de Hounde	946	283	15.8	4.7	2	13.8	2.7
C3	4026	Clinique Lorentia	110	NA	1.8	NA	0	1.8	NA
C4	6402	CHU Yalgado Ouedraogo	7958	4382	132.6	73.0	6	126.6	67.0
C5	3733	CMA de Tougan	1198	160	20.0	2.7	2	18.0	0.7
C6	4623	CMA de Diebougou	517	110	8.6	1.8	2	6.6	-0.2
C7	3222	CHR Dori	1635	204	27.2	3.4	3	24.2	0.4
C8	4713	CHR de Gaoua	812	277	13.5	4.6	1	12.5	3.6
C9	4007	CMA de Orodara	312	348	5.2	5.8	2	3.2	3.8
C10	720	Clinique Kone Moussa	33	NA	0.6	NA	2	-1.4	NA
C11	417	CMA du secteur 30	402	738	6.7	12.3	3	3.7	9.3
C12	1225	CMA de Kongoussi	2026	139	33.8	2.3	2	31.8	0.3
C13	3807	CHR de Dedougou	1425	270	23.7	4.5	2	21.7	2.5
C14	1628	CHR de Koudougou	1973	653	32.9	10.9	3	29.9	7.9
C15	3627	CMA de Solenzo	362	421	6.0	7.0	2	4.0	5.0
C16	24	CMA du secteur 26	242	NA	4.0	NA	0	4.0	NA
C17	2328	CMA de Zorgho	4195	367	69.9	6.1	3	66.9	3.1
C18	4420	CHU Souro Sanou	2977	944	49.6	15.7	6	43.6	9.7
C19	2931	CHR de Fada	3015	344	50.2	5.7	3	47.2	2.7
C20	3436	CHR de Banfora	628	390	10.5	6.5	2	8.5	4.5
C21	1135	CHR de Kaya	1384	424	23.1	7.1	2	21.1	5.1

| | | **Total** | 32490 | | 541.5 | | 53 | 488.5 | |