





COVID-19: Supporting the Government of Namibia with mobility data

Flowminder Foundation





Center for International Earth Science Information Network FARTH INSTITUTE | COLUMBIA UNIVERSITY



Authors

Flowminder Foundation is a non-profit foundation specialising in the analysis of anonymous mobile phone data, satellite imagery and household survey data for humanitarian and development purposes. Flowminder provides insight and strengthen the capacity of governments, mobile network operators, national and international agencies and researchers to use big data for humanitarian and development purposes. Flowminder is one of the implementing partners of the GRID3 programme, currently operational in Namibia. www.flowminder.org | covid19.flowminder.org | grid3.org

MTC Namibia, MTC is a public company registered in terms of the Companies Act of Namibia, No. 28 of 2004, as amended (Companies Act of Namibia) and wholly owned by Namibia Post and Telecom Holdings Limited (NPTH), a government entity. MTC plans to apply for a listing on the Namibian Stock Exchange (NSX) within the next year. As a wholly owned subsidiary of the Namibian government, and a dominant participant in Namibia's telecommunications market, MTC is positioned to be a digital enabler of change. MTC's mobile network covers 97% of Namibia's population and over 86% of Namibians have access to MTC's mobile broadband. MTC is committed to achieving 100% coverage of the Namibian population and improving the lives of customers through innovative digital solutions that will enable us to be the best digital provider that meets customer expectations. MTC commitments are being fulfilled through its innovative digital solutions, the 081Every1 project, which is expanding MTC's services to Namibians in remote rural areas, and its continued efforts to ensure their infrastructure supports the needs of customers. MTC is a preferred employer and the most recognized communications brand in Namibia – nine out of 10 customers would recommend MTC to others.

Namibia Statistics Agency, collaborated with Flowminder to produce this report and are actively exploring future collaborations with mobile operators to integrate CDR data with other data sources to produce new and exciting insights. The Namibia Statistics Agency is mandated to be the central statistical authority of the state. Its purpose is to collect, produce, analyse and disseminate official and other statistics in Namibia. The purpose is also to facilitate the capture, management, maintenance, integration, distribution and use of spatial data.





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Our Vision Mapping a path to sustainable development for everyone.

Our Mission To build spatial data solutions that make development goals achievable.





Housing census & hybrid method support



High-resolution population estimates



Capacity Strengthening



Locating critical infrastructure

Subnational boundaries



Comprehensive settlement locations



Mobility analysis







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About Flowminder

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Flowminder's mission: Enabling decision makers to access the data they need to transform the lives of vulnerable people at scale

- Non-profit organisation
 - Supporting governments and mobile operators to use insights from mobile operator data to improve government decision-making
- Pioneered of the analysis of mobile network data to support responses to infectious disease outbreaks and natural disasters





Privacy & data governance

- Flowminder releases aggregated and anonymised statistics
- No individual level data leaves the country
- No individual level data leaves the control of the mobile network operator
- GDPR compliant
- Open code to allow peer review and build trust





Call Detail Records (CDR data)

- Base stations/towers with multiple cells
- Mobile Network Operators maintain a database of CDRs for billing purposes
 - Generated each time a
 mobile phone subscriber
 makes or receives a call,
 sends or receives a SMS, or
 uses mobile data.
 - See annex 1 for main caveats of CDR data



FLOWMINDER.ORG Introduction to mobile operator data

The value of mobility data for decision-making

Using mobility data for the COVID-19 response











Knowledge of existing mobility patterns & their changes Knowledge of population redistributions

Informed epidemic scenario planning and modeling Identification and monitoring of areas with high population mixing Post the COVID-19 response: core building blocks for an improved outbreak and disaster response



Analysis Period of analysis & data coverage



Key dates:

- Baseline period: 16 February 16 March
- Comparison period: 17 March 14 October

Reading the graphs: Most results are expressed as percentage changes from the baseline period preceding the announcement of the state of national emergency (17 March), i.e. compared to normal conditions. The timeline below summarises the period of analysis.



Data sources: MTC provided de-identified Call Detail Records (CDR) of their subscribers to Flowminder on a server installed behind the MTC firewall (subscriber privacy was thereby protected and no individual subscriber identifiable). Flowminder then aggregated the records (see <u>here</u> and <u>here</u> for methodology). Flowminder then derived the mobility indicators presented in this report (see <u>here</u> for the method).

FLOWMINDER.ORG Report 1 Study period and data sources



Report 1 Key takeaways

Shofar Christian Church

Reduction in flows to Erongo and Khomas during lockdown:

- During the stage 1 and national lockdowns, weekday flows to and from Khomas were much lower than during the baseline period (-46%), i.e. only half that of a normal Sunday during the baseline period.
- In Erongo, the decrease in weekday flows during the stage 1 and national lockdowns was similar, with flow a median of 47% below baseline.

During stage and national lockdown, increased flows to border regions and increased presence in these regions:

Substantially higher than baseline flow to and from some constituencies in Ohangwena (e.g. median 15% increase in Ondobe, 18% in Omulonga), Oshikoto (18% in Omuntele), Zambezi (39% in Kabbe), and Omusati (25% in Otamanzi).

FLOWMINDER.ORG Report 1 | Key takeaways (1/2)



Increases in mobility following announcements of stage 1 lockdown:

 Flows between regions increased by more than 40% on the day before stage 1 lockdown, before reducing by 10–20% during the lockdown.

Signs of a return to normal during September and early October:

- From late September to early October, presence and flow were were approaching baseline levels in most regions.
- Presence remained marginally higher than the baseline near Angola border.

'Bounce back' during stage 2 lockdown:

 Evidence of a 'rebound' in mobility and presence during stage 2 lockdown, but it is possible that mobility would be higher than normal during these month in an ordinary year because of normal seasonal factors.

FLOWMINDER.ORG Report 1 | Key takeaways (2/2)



Analysis Mobility



Number of constituencies visited

Key events: 1) Baseline start, 2) State of emergency declared, 3) Stage 1 lockdown, 4) National lockdown, 5) Stage 2 lockdown, 6) Stage 3 lockdown, 7) Stage 4 lockdown, 8) Local lockdown of Windhoek, Okahandja, Rehoboth



Definition: The line shows the change in the average number of constituencies within a region visited per day per subscriber in the country, with Sundays indicated by white dots.

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Overview of the graph

Mobility between constituencies was sharply reduced (25% lower weekday mobility) by the stage 1 and national lockdowns, remaining slightly below baseline levels through stage 2-4 lockdowns and returning to close to normal levels in late September.

Interpretation

Mobility within regions shows greater reductions than between regions (for example, movement around Erongo and Khomas is captured here). It may also reflect the greater ability of the indicator to detect movement over short distances and time periods.

The 5-10% reductions during the initial lockdown period may have helped slow the initial spread of the virus, conversely the increasing trend from mid-August may have helped feed the growth in nown COVID-19 cases in the latter part of the month.



Definition: Constituencies are coloured according to their median percentage change from mobility during the baseline period, red dots indicate border crossings.

Within constituency mobility Stage 1 and national lockdowns

Overview of the map

The map shows the median percentage changes in mobility between towers for each constituency, during the national and stage 1 lockdown period (28th of March – 5th of May). Most constituencies show below baseline mobility, with large falls observed in most of Windhoek and surrounding areas.

Interpretation

The reduction in movements within constituencies may have helped reduced the spread of the virus.

Within Windhoek, mobility is slightly elevated in the suburban Moses Garoëb constituency, which may reflect more movement around their local area from those staying home from work.





Definition: Constituencies are coloured according to their median percentage change from mobility during the baseline period, red dots indicate border crossings.

Within constituency mobility September to 14 October

Overview of the map

The map shows the median percentage changes in mobility between towers for each constituency, during the stage 4 lockdown period and beyond. Most constituencies continue to show slightly reduced baseline mobility (median change from baseline of 1% across all constituencies, biggest median reduction of 19%).

Interpretation

Most constituencies have begun to return to normal levels of mobility, but remain slightly or moderately below baseline levels. This suggests that recovery from restrictions have not been immediate, but is gradually progressing.



Results Flows





Definition: Constituencies are coloured according to their median absolute change from subscriber presence during the baseline period.

Stage 3 lockdown

Overview of the graph

During stage 3 lockdown the majority of constituencies showed presence close to baseline levels.

Presence in Erongo and Khomas remained reduced. A smaller number of constituencies close to the border with Angola continued to have greater than usual presence, but to a lesser extent than during previous lockdown stages.



Region level flow

Key events: 1) Baseline start, 2) State of emergency declared, 3) Stage 1 lockdown, 4) National lockdown, 5) Stage 2 lockdown, 6) Stage 3 lockdown, 7) Stage 4 lockdown, 8) Local lockdown of Windhoek, Okahandja, Rehoboth



Definition: The line shows change in the total number of trips between regions, with Sundays indicated by white dots.



Overview of the graph

Weekday flow between regions reduced by 15-20% during the stage 1 and national lockdowns, grew slightly (median 12.4% above baseline) during the stage 2 lockdown, and returned to close to normal levels following stage 3 lockdown. There is high day-to-day variability in this metric.

Interpretation

Movement between regions reduced significantly during stage 1 and national lockdowns, below the level of a normal sunday, which may have helped slow initial spread of the virus. However there were still movements throughout lockdown, and a large spike in movements the day before stage 1 lockdown, which may have led to accelerated dispersal of the virus initially.



Total flows for each constituency

Stage 1 and national lockdowns

Overview of the map

The map shows the median absolute changes in total flow to and from each constituency, during the national and stage 1 lockdown period. Most constituencies show some reduction in flow, and very large reductions in total flows are observed in Windhoek and surrounding areas. However, many northern constituencies had a greater than usual flow during the lockdown, as did several border constituencies with Botswana (moderate increases in total flows).

Interpretation

The reduction in movements to and from Erongo and Khomas may have helped reduced the spread of the virus.

The increased flows to and from some northern and border regions may indicate some movement out of country, particularly to Angola, or an increase in informal trade. Given there is a known seasonal movement to Northern regions around Christmas, this may also indicate that people have migrated temporarily to visit with friends and family.

Definition: Constituencies are coloured according to their **median absolute change** from total in and out flow during the baseline period, red dots indicate border crossings. The map enables us to compare changes in total flows (subscribers) for each region, which are categorised as small/moderate/large (either decreasing or increasing), as we cannot show subscriber numbers. These are not % changes relative to each constituency.





Total flows for each constituency September to 14 October

Overview of the map

The map shows the median absolute change in flow to and from each constituency during September through to 14 October.

Southern and central regions have begun to return to close to the baseline, but the picture in the north is more mixed. Flow remains mildly reduced around Walvis Bay, Windhoek and Rehoboth, and remains higher than usual in some regions bordering Angola and Botswana.

Interpretation

Compared to the initial lockdown period, most Southern and central areas have closer to baseline levels of in and out flow, which may be facilitating economic recovery but could also increase the risk of an increase in the spread of the virus.

Movements to and from some constituencies at the northern and and eastern borders remain elevated, although this may be linked to the end of the dry season or other local seasonal factors.



Definition: Constituencies are coloured according to their median absolute change from total in and out flow during the baseline period, red dots indicate border crossings.

Constituency level flow

Key events: 1) Baseline start, 2) State of emergency declared, 3) Stage 1 lockdown, 4) National lockdown, 5) Stage 2 lockdown, 6) Stage 3 lockdown, 7) Stage 4 lockdown, 8) Local lockdown of Windhoek, Okahandja, Rehoboth



Definition: The line shows change in the total number of trips between constituencies, with Sundays indicated by white dots.



Overview of the graph

Weekday flow between constituencies was reduced by 30-40% during the stage 1 and national lockdowns, recovering to slightly below normal levels for the remaining period.

There was a smaller 10-20% reduction compared to baseline following local lockdowns of Windhoek, Okahandja and Rehoboth.

Interpretation

Flow between constituencies was relatively more reduced as compared to the baseline during all stages of lockdown. This reduced movement between constituencies may have helped reduce the spread of the virus. However, we should note that trips spanning more than a 24 hour period are not captured by this metric because it only considers trips taking place within one day, so, for example, travelling from Windhoek to Opuwo without a motor vehicle would not be reflected.

Cluster level flow

Key events: 1) Baseline start, 2) State of emergency declared, 3) Stage 1 lockdown, 4) National lockdown, 5) Stage 2 lockdown, 6) Stage 3 lockdown, 7) Stage 4 lockdown, 8) Local lockdown of Windhoek, Okahandja, Rehoboth



Definition: The line shows change in the total number of trips between clusters, with Sundays indicated by white dots. Clusters are grouped into central (NA13, NA09, NA06, NA02), Southern (NA03, NA04), and Northern (NA07, NA10, NA11, NA08, NA12, NA14, NA05, NA01).



Overview of the graph

During the stage 1 and national lockdowns, weekday movements between clusters (a cluster is a grouping of nearby cell towers) reduced by more than 60% (similar to a normal Sunday) in central constituencies, close to 40% in southern constituencies, and a more modest 5-10% in northern areas.

Northern areas had entirely recovered as of the beginning of stage 4 lockdown, with signs of an upward trend in flow in central and southern areas during October, although flow remained 10-20% below normal levels.

Flows were slightly lower following the local lockdowns of Windhoek, Okahandja and Rehoboth.

Interpretation

Flow between clusters in central areas exhibits a particularly clear weekday pattern because of the dominance of trips within Erongo and Khomas. The local lockdown of Windhoek is also very apparent for this reason.

The large reductions in movement between clusters is likely to have helped inhibit spread of the virus, but the ongoing reduction may have had a negative economic impact.

Caveat

In dense urban areas, subscribers may appear to visit multiple clusters without actually moving because their phone may connect to multiple cell towers dependent on $_{30}$ signal strength and network traffic.

Median travelled distance

Key events: 1) Baseline start, 2) State of emergency declared, 3) Stage 1 lockdown, 4) National lockdown, 5) Stage 2 lockdown, 6) Stage 3 lockdown, 7) Stage 4 lockdown, 8) Local lockdown of Windhoek, Okahandja, Rehoboth



Definition: The line shows change in the tower level median travelled distance, with Sundays indicated by white dots.



Overview of the graph

Weekday travelled distance dropped by 81% relative to the baseline during the stage 1 and national lockdowns, but exhibited a 40+% increase immediately before stage 1 lockdown. Travelled distance returned to close to normal after the lockdown eased to stage 2, but reduced again during stage 3 (-40%) and 4 (-45%), with a further reduction after the imposition of local lockdowns, returning to normal levels in late September.

Interpretation

Median travelled distance suggests that subscribers tended to travel much smaller distances during the stage 1, 3, 4 and national lockdowns compared to the baseline. This may particularly reflect fewer journeys to the major commercial areas from the rest of the country, with an additional reduction following tightening restrictions in Windhoek, Okhandja and Rehoboth.

Flow to and from Erongo

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Key events: 1) Baseline start, 2) State of emergency declared, 3) Stage 1 lockdown, 4) National lockdown, 5) Stage 2 lockdown, 6) Stage 3 lockdown, 7) Stage 4 lockdown, 8) Local lockdown of Windhoek, Okahandja, Rehoboth



Definition: The line shows change in the total flow to and from Erongo compared to the baseline median, with Sundays indicated by white dots.

Overview of the graph

Movements in and out of Erongo reduced by 40+% following the initial lockdown - less than half the traffic of the median baseline Sunday,

Flow returned to close to normal levels during stage 2 lockdown but fell again during stage 3 with signs of recovery during late september.

Flows increased by 80+% two days before the imposition of stage 1 lockdown.

Interpretation

Flow in and out of Erongo was reduced for all lockdown phases except stage 2. Additionally, the pattern of flow more closely follows a weekly pattern, suggesting that movement in and out was primarily commuting. The reduction in movements in and out may have helped reduce the spread of the virus out of the region.

Two days before the lockdown began, there was a large increase in mobility, likely driven by people preparing for lockdown, or relocating. This may have increased the risk of infections.

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Flow to and from Khomas

Key events: 1) Baseline start, 2) State of emergency declared, 3) Stage 1 lockdown, 4) National lockdown, 5) Stage 2 lockdown, 6) Stage 3 lockdown, 7) Stage 4 lockdown, 8) Local lockdown of Windhoek, Okahandja, Rehoboth



Definition: The line shows change in the total flow to and from Khomas compared to the baseline median, with Sundays indicated by white dots.

Overview of the graph

Flows in and out of Khomas fell by more than 40% (weekdays slightly below a normal Sunday) during the stage 1 and national lockdowns, remaining reduced for the rest of the study period at ~10% below normal.

Interpretation

Flow between Khomas and other regions shows a similar pattern to Erongo, but with a lesser impact outside of the first and national lockdowns.

The reductions in mobility may have helped contain the spread of the virus from and to this region, but may also have have had deleterious economic impacts given the slightly below normal levels of flow over the summer months.



Analysis Presence



Presence in Erongo and Khomas

Key events: 1) Baseline start, 2) State of emergency declared, 3) Stage 1 lockdown, 4) National lockdown, 5) Stage 2 lockdown, 6) Stage 3 lockdown, 7) Stage 4 lockdown, 8) Local lockdown of Windhoek, Okahandia, Rehoboth



Definition: The lines show change in the number of subscribers observed in a region each day compared to the baseline median, with Sundays indicated by white dots.

Overview of the graph

The presence of subscribers in both Erongo and Khomas was reduced following the stage 1 lockdown and remained marginally lower than baseline levels as of early October.

Presence in Khomas was more substantially reduced, more than 4 times less than usual Sunday. Erongo shows a reversal from slightly higher Sunday presence through lockdowns.

Interpretation

Contrasting the changes in presence with changes in flow is informative here, because while reductions to flow during stage 1 and national lockdowns were similar for Khomas and Erongo, the reduction in presence is much more pronounced for Khomas, likely because it is less residential, and continues to be reduced by 2.5-5%. This may indicate a long lived economic impact on the region, but could also have helped curtail virus spread in commercial areas.



Presence in Walvis Bay

Key events: 1) Baseline start, 2) State of emergency declared, 3) Stage 1 lockdown, 4) National lockdown, 5) Stage 2 lockdown, 6) Stage 3 lockdown, 7) Stage 4 lockdown



Definition: The lines show change in the number of subscribers observed in a region each day compared to the baseline median, with Sundays indicated by white dots.

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Overview of the graph

Presence in Walvis Bay, especially the urban areas reduced sharply following the stage 1 lockdown and remains up to 10% lower than pre-state of emergency levels as of early October. During the baseline, the median weekday presence in urban areas was 51% of the total for urban and rural, this fell to 45% during the stage 1 and national lockdowns.

Interpretation

There was a significant an ongoing reduction in the number of subscribers present in Walvis Bay across lockdown, with presence remaining reduced at the end of the study period. This may have helped reduce the impact of the cluster of COVID-19 cases observed in the constituency early in the pandemic, although as observed elsewhere there was a spike in flow to and from the area prior to the imposition of lockdown. Rural areas were less impacted (because likely to have a larger proportion of residents over all subscribers present there), but there is likely to have been significant economic impact from the reduction in presence.

Presence in Swakopmund, Okahandja and Arandis

Key events: 1) Baseline start, 2) State of emergency declared, 3) Stage 1 lockdown, 4) National lockdown, 5) Stage 2 lockdown, 6) Stage 3 lockdown, 7) Stage 4 lockdown



Definition: The lines show change in the number of subscribers observed in a region each day compared to the baseline median, with Sundays indicated by white dots.

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Overview of the graph

Presence in all three regions reduced during all lockdown phases, but has largely recovered as of late September-early October. Reductions were more pronounced in Arandis.

Interpretation

The largest reduction in presence can be observed in Arandis, although in all three areas presence was close to baseline during stage 2 lockdown. The reduction in Arandis may be primarily attributable to a significant step down in on-site activities by Rössing Uranium. All three areas also saw elevated presence immediately prior to the initial lockdown, particularly Okahandja. These increase may have been the result of people seeking to prepare for lockdown, and may have increased the risk of spread early in the pandemic

Presence has returned largely to normal levels as of late September.

The sustained reduction in presence in Arandis is likely to have had a negative impact on the local economy outside of Rössing.



Stage 1 and National lockdown

Overview of the graph

The map shows the median absolute change from subscriber presence during the baseline at constituency level. Central regions show moderate to large decreases in presence, with increases in some constituencies within Omusati, Omaheke, Otjozondjupa, Ohangwena, Oshikoto and the Zambezi strip.

Interpretation

The change in presence of subscribers during lockdown tracks closely with changes to constituency level flow, suggesting that many people who would ordinarily have been in Khomas and Erongo either remained at home, or actively moved towards the north. This is likely to have reduced the spread within Khomas and Erongo, but may have increased transmission in the now more occupied northern areas, e.g. Kabbe, or Ongenga.







Stage 2 lockdown

Overview of the graph

During stage 2 lockdown, subscriber presence in most regions returned to close to baseline levels, with reductions concentrated in Khomas and around Walvis Bay. Subscriber presence was above normal levels in multiple constituencies in Omatusi, Ohangwena and Kunene.

Interpretation

Stage 2 lockdown shows a less severe reduction in subscriber presence in Khomas.

There continued to be increased presence in the north. This could have increased the spread of COVID-19 in these areas, but may also have had a positive impact on the local economy although this is unlikely to have offset the impact of lockdown on Khomas and Erongo.

Definition: Constituencies are coloured according to their median absolute change from subscriber presence during the baseline period.





Stage 4 lockdown

Overview of the graph

During stage 4 most regions approached baseline levels, with the notable exception of a small to moderate increase in presence in the Karasburg constituency, which is likely to be a seasonal effect linked to farming.

Presence in Windhoek remained reduced to a similar extent to stage 3 lockdown, although as seen in the time series plots for Erongo, this is was not constant over the period.

Interpretation

The overall picture is largely that of a return to normal, although the ongoing lower than baseline presence in Erongo, Khomas, Walvis Bay and Okahandja may suggest that the economic impact is ongoing.

Definition: Constituencies are coloured according to their median absolute change from subscriber presence during the baseline period.



Annexes

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Annex 1 Data considerations

Photo credit: S Martin, Flickr

Data quality

System or processing issues	Analysis issues
Data missing for some time period	Spatial resolution
Corrupted records	Temporal resolution
Errors in location e.g. location is outside country borders	Representativeness of the data
	Not everyone uses a mobile phone We only have data from one MNO One SIM doesn't always correspond to one person



Spatial resolution

The density of cell towers affects the

precision of our location estimates.

Furthermore, the location of the cell

tower is often the only available

information about its potential

coverage.





Temporal resolution

We only 'see' a subscriber when they use their phone.

If they don't use their phone on a particular day, we can't confidently say where they are

on that day.







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