Mapping of Health related facilities in three Urban Informal Settlements in Dhaka City

CODE

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1 Methods

1.1 Interactive mapping

While static maps in standard image formats are the most common type of visual output from geocomputation, interactive maps would useful for communicating ideas and geographic data visualisation quickly. In addition, user friendly maps would engage the audience to play with the maps themselves to serve their purpose. Also, interactive maps are also often the best way to present the findings of geocomputational research in a way that is accessible to users. Therefore, map making is a critical part of geocomputation and its emphasis not only on describing, but also changing the world though data visualization (Muenchow, 2021). This initiative is to show how to create an interactive map from scratch to demonstrate the features of three urban slums in Dhaka City.

1.2 Software

R Programming language has been used to create interactive maps with features. R is a free software which is used for statistical computing and graphics (R Core Team, 2021). Initially, static maps were the only type of maps that R could produce. Things advanced with the release of “sp” package and many techniques for map making have been developed since then. R Programming with appropriate map making packages enable anyone to make high-quality maps.

1.3 R setting

R is always pointed at a directory on our computer. We can find out which directory by running the getwd (get working directory) function without arguments. To change our working directory, we use setwd (set working directory) function and specify the path to the desired folder. We need to set working directory and path after cleaning up everything including your global environment of both r objects and loaded packages. Sometimes it is useful to Check r-version using print(version$version.string) function to be compatible for analysis to some extent.

HIDE

```
rm(list=ls()) # Clean up everything
# Set working directory
setwd("F:/Maps") # setting path of working directory
print(version$version.string) # Checking r-version
```

1.4 Required packages

As soon as local directory is set, we need to load required R packages such as tidyverse (Wickham, 2021), leaflet (Cheng, Karambelkar, et al., 2021), leafpop (Appelhans & Detsch, 2021), magrittr (Bache & Wickham, 2020), htmltools (Cheng, Sievert, et al., 2021), rjson (Couture-Beil, 2018), jsonlite (Ooms, 2020), reactable (Lin, 2020), htmlwidgets (Vaidyanathan et al., 2020), readr (Wickham & Hester, 2020), dplyr (Wickham et al., 2021), geospere (Robert, 2019), and table1 (Rich, 2021).

HIDE

```
# Loading packages
library("tidyverse")
library("leaflet")
library("htmltools")
library("leafpop")
library("magrittr")
library("rjson")
library("jsonlite")
library("reactable")
library("htmlwidgets")
library("table1")
library("formatR")
library("geosphere")
```

1.4.1 Loading Data

The next step is to load primary data, stored at local directory, on health related facilities along with GPS coordinates of respective facilities collected by co-researchers from respective slums.

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```
shyampur_slum <- readr::read_csv("shyampur_slum.csv")
kallayanpur_slum <- readr::read_csv("kallayanpur_slum.csv")
dholpur_slum <- readr::read_csv("dholpur_slum.csv")
description_keyterms_slum <- read_csv("description_keyterms_slum.csv")
comparison_slums <- readr::read_csv("comparison_slums.csv")
```

1.5 Data manipulation

1.5.1 Renaming columns

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```
names(shyampur_slum) <- c("Facilities", "Details of facilities", "Longitude", "Latitude")
names(kallayanpur_slum) <- c("Facilities", "Details of facilities", "Longitude", "Latitude")
names(dholpur_slum) <- c("Facilities", "Details of facilities", "Longitude", "Latitude")
```

1.5.2 Sub-setting data: Kallayanpur

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```
names(kallayanpur_slum) <- c("Facilities", "details", "lng", "lat")
hcf_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Health Care Facilities")
wcp_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Water collection point")
saf_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Sanitation")
edi_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Educational institute")
rep_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Religious Place")
gov_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Government Structure")
plg_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Playground")
cmc_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Community center")
clb_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Club")
bzr_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Bazar")
wst_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Waste disposal")
fpa_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Fire prone area")
usz_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Unsafe Zone")
wla_kslums <- dplyr::filter(kallayanpur_slum, Facilities %in% "Waterlogging area")
```

1.5.3 Sub-setting data: Dholpur

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```
names(dholpur_slum) <- c("Facilities", "details", "lng", "lat")
hcf_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Health Care Facilities")
wcp_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Water collection point")
saf_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Sanitation")
edi_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Educational institute")
rep_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Religious Place")
gov_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Government Structure")
plg_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Playground")
cmc_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Community center")
clb_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Club")
bzr_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Bazar")
wst_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Waste disposal")
epa_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Eviction prone area")
fpa_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Fire prone area")
poe_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Place of entertainment")
usz_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Unsafe Zone")
wla_dslums <- dplyr::filter(dholpur_slum, Facilities %in% "Waterlogging area")
```

1.5.4 Sub-setting data: Shyampur

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```
names(shyampur_slum) <- c("Facilities", "details", "lng", "lat")
hcf_sslums <- dplyr::filter(shyampur_slum, Facilities %in% "Health Care Facilities")
wcp_sslums <- dplyr::filter(shyampur_slum, Facilities %in% "Water collection point")
saf_sslums <- dplyr::filter(shyampur_slum, Facilities %in% "Sanitation")
edi_sslums <- dplyr::filter(shyampur_slum, Facilities %in% "Educational institute")
rep_sslums <- dplyr::filter(shyampur_slum, Facilities %in% "Religious Place")
wst_sslums <- dplyr::filter(shyampur_slum, Facilities %in% "Waste disposal")
epa_sslums <- dplyr::filter(shyampur_slum, Facilities %in% "Eviction prone area")
fpa_sslums <- dplyr::filter(shyampur_slum, Facilities %in% "Fire prone area")
poe_sslums <- dplyr::filter(shyampur_slum, Facilities %in% "Place of entertainment")
usz_sslums <- dplyr::filter(shyampur_slum, Facilities %in% "Unsafe Zone")
wla_sslums <- dplyr::filter(shyampur_slum, Facilities %in% "Waterlogging area")
shyampur_slum_poe <- dplyr::filter(shyampur_slum, !Facilities %in% "Place of entertainment")
```

1.6 Knitting codes to create map

Now we can bring the three slums data together into a simple map using the leaflet package (Cheng, Karambelkar, et al., 2021; Dray, 2018). This package wraps up some functions from the Leaflet JavaScript library (https://leafletjs.com/). First we'll call the leaflet package from our library stored in local drive.

1.6.1 Creating boundary: Kallayanpur

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```
outline_k <- kallayanpur_slum[chull(kallayanpur_slum$lng, kallayanpur_slum$lat),]
```

1.6.2 Creating boundary: Dholpur

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```
outline_d <- dholpur_slum[chull(dholpur_slum$lng, dholpur_slum$lat),]
```

1.6.3 Creating boundary: Shyampur

HIDE

```
outline_s <- shyampur_slum_poe[chull(shyampur_slum_poe$lng, shyampur_slum_poe$lat),]
```

1.6.4 Creating Leaflet map: Kallayanpur

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```
kallayanpur_slum_map <- kallayanpur_slum %>%
  leaflet() %>%
  addProviderTiles(providers$Esri.WorldImagery, group = "World Imagery") %>%
  addProviderTiles(providers$Stamen.TonerLite, group = "Toner Lite") %>%
  addProviderTiles(providers$OpenStreetMap, group = "Open SM") %>%
  addPolygons(data = outline_k, lng = outline_k$lng, lat = outline_k$lat, fill = FALSE, weight = 4, color = "re
        d", opacity = 1, group = "Kallayanpur slum boundary") %>%
  addCircleMarkers(lng = hcf_kslums$lng, lat = hcf_kslums$lat, weight = 2, fillOpacity = 1, color = 'red', radiu
        s = 5, opacity = 1, group = "Pharmacy with(out) doctor", popup = hcf_kslums$details, options = popupOpt
        ions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = wcp_kslums$lng, lat = wcp_kslums$lat, weight = 2, fillOpacity = 1, color = 'black', rad
        ius = 5, opacity = 1, group = "Drinking water collection point", popup = wcp_kslums$details, options =
        popupOptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = saf_kslums$lng, lat = saf_kslums$lat, weight = 2, fillOpacity = 1, color = 'green', rad
        ius = 5, opacity = 1,  group = "Toilet and washing point", popup = saf_kslums$details, options = popupO
        ptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = edi_kslums$lng, lat = edi_kslums$lat, weight = 2, fillOpacity = 1, color = 'cyan', radi
        us = 5, opacity = 1, group = "School or learning center", popup = edi_kslums$details, options = popupOp
        tions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = rep_kslums$lng, lat = rep_kslums$lat, weight =2, fillOpacity = 1, color = 'purple', rad
        ius = 5, opacity = 1, group = "Mosque or Temple", popup = rep_kslums$details, options = popupOptions(ke
        epInView = TRUE)) %>%
  addCircleMarkers(lng = gov_kslums$lng, lat = gov_kslums$lat, weight =2, fillOpacity = 1, color = 'darkblue', r
        adius = 5, opacity = 1, group = "Government structure", popup = gov_kslums$details, options = popupOpti
        ons(keepInView = TRUE)) %>%
  addCircleMarkers(lng = plg_kslums$lng, lat = plg_kslums$lat, weight =2, fillOpacity = 1, color = 'maroon', rad
        ius = 10, opacity = 1, group = "Playground", popup = plg_kslums$details, options = popupOptions(keepInV
        iew = TRUE)) %>%
  addCircleMarkers(lng = cmc_kslums$lng, lat = cmc_kslums$lat, weight =2, fillOpacity = 1, color = 'orange', rad
        ius = 10, opacity = 1, group = "Community center", popup = cmc_kslums$details, options = popupOptions(k
        eepInView = TRUE)) %>%
  addCircleMarkers(lng = clb_kslums$lng, lat = clb_kslums$lat, weight =2, fillOpacity = 1, color = 'blueviolet',
        radius = 10, opacity = 1, group = "Community club", popup = clb_kslums$details, options = popupOptions(
        keepInView = TRUE)) %>%
  addCircleMarkers(lng = bzr_kslums$lng, lat = bzr_kslums$lat, weight =2, fillOpacity = 1, color = '#00CC66', ra
        dius = 5, opacity = 1, group = "Bazar", popup = bzr_kslums$details, options = popupOptions(keepInView =
        TRUE)) %>%
  addCircleMarkers(lng = wst_kslums$lng, lat = wst_kslums$lat, weight =2, fillOpacity = 1, color = 'darkred', ra
        dius = 5, opacity = 1, group = "Waste disposal point", popup = wst_kslums$details, options = popupOptio
        ns(keepInView = TRUE)) %>%
  addCircleMarkers(lng = fpa_kslums$lng, lat = fpa_kslums$lat, weight =2, fillOpacity = 1, color = '#0000FF', ra
        dius = 5, opacity = 1, group = "Fire prone area", popup = fpa_kslums$details, options = popupOptions(ke
        epInView = TRUE)) %>%
  addCircleMarkers(lng = usz_kslums$lng, lat = usz_kslums$lat, weight =2, fillOpacity = 1, color = '#FF00CC', ra
        dius = 5, opacity = 1, group = "Unsafe zone", popup = usz_kslums$details, options = popupOptions(keepIn
        View = TRUE)) %>%
  addCircleMarkers(lng = wla_kslums$lng, lat = wla_kslums$lat, weight =2, fillOpacity = 1, color = '#333033', ra
        dius = 5, opacity = 1, group = "Waterlogging area", popup = wla_kslums$details, options = popupOptions(
        keepInView = TRUE)) %>%
  #fitBounds(lng1 = min(kallayanpur_slum$lng), lat1 = min(kallayanpur_slum$lat), lng2 = max(kallayanpur_slum$ln
        g), lat2 = max(kallayanpur_slum$lat)) %>%
  addMiniMap(toggleDisplay = TRUE, tiles = providers$OpenStreetMap) %>%
  #addGraticule(group = "Graticule", interval = 0.02, style = list(color = "#FF0000", weight = 1)) %>%
  addLayersControl(baseGroups = c("Open SM", "Toner Lite", "World Imagery"), options = layersControlOptions(coll
        apsed = FALSE),
                   overlayGroups = c("Kallayanpur slum boundary",
                                     #"Graticule",
                                     "Pharmacy with(out) doctor",
                                     "Drinking water collection point",
                                     "Toilet and washing point",
                                     "School or learning center",
                                     "Mosque or Temple",
                                     "Government structure",
```

```
                                    "Playground",
                                    "Community center",
                                    "Community club",
                                    "Community club",
                                    "Bazar",
                                    "Waste disposal point",
                                    "Fire prone area",
                                    "Unsafe zone",
                                    "Waterlogging area")) %>%
  hideGroup(c(#"Pharmacy with(out) doctor",
    "Drinking water collection point",
    "Toilet and washing point",
    "School or learning center",
    "Mosque or Temple",
    "Government structure",
    "Playground",
    "Community center",
    "Community club",
    "Community club",
    "Bazar",
    "Waste disposal point",
    "Fire prone area",
    "Unsafe zone",
    "Waterlogging area")) %>%
  addControl('<a rel="license" href="http://creativecommons.org/licenses/by-nc-sa/4.0/">
              <img alt="Creative Commons License" style="border-width:0" src="https://i.creativecommons.org/l/by-
        nc-sa/4.0/88x31.png" /></a>',
              position = "bottomleft")%>%
  addMeasure(
    position = 'bottomleft',
    primaryLengthUnit = 'meters',
    primaryAreaUnit = 'sqmeters',
    activeColor = '#3D535D',
    completedColor = '#7D4479')
```

1.6.5 Creating Leaflet map: Dholpur

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```
dholpur_slum_map <- dholpur_slum %>%
  leaflet() %>%
  addProviderTiles(providers$Esri.WorldImagery, group = "World Imagery") %>%
  addProviderTiles(providers$Stamen.TonerLite, group = "Toner Lite") %>%
  addProviderTiles(providers$OpenStreetMap, group = "Open SM") %>%
  addPolygons(data = outline_d, lng = outline_d$lng, lat = outline_d$lat, fill = FALSE, weight = 4, color = "re
        d", opacity = 1, group = "Dholpur slum boundary") %>%
  addCircleMarkers(lng = hcf_dslums$lng, lat = hcf_dslums$lat, weight = 2, fillOpacity = 1, color = 'red', radiu
        s = 5, opacity = 1, group = "Pharmacy with(out) doctor", popup = hcf_dslums$details, options = popupOpt
        ions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = wcp_dslums$lng, lat = wcp_dslums$lat, weight = 2, fillOpacity = 1, color = 'black', rad
        ius = 5, opacity = 1, group = "Drinking water collection point", popup = wcp_dslums$details, options =
        popupOptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = saf_dslums$lng, lat = saf_dslums$lat, weight = 2, fillOpacity = 1, color = 'green', rad
        ius = 5, opacity = 1,  group = "Toilet and washing point", popup = saf_dslums$details, options = popupO
        ptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = edi_dslums$lng, lat = edi_dslums$lat, weight = 2, fillOpacity = 1, color = 'cyan', radi
        us = 5, opacity = 1, group = "School or learning center", popup = edi_dslums$details, options = popupOp
        tions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = rep_dslums$lng, lat = rep_dslums$lat, weight =2, fillOpacity = 1, color = 'purple', rad
        ius = 5, opacity = 1, group = "Mosque or Temple", popup = rep_dslums$details, options = popupOptions(ke
        epInView = TRUE)) %>%
  addCircleMarkers(lng = gov_dslums$lng, lat = gov_dslums$lat, weight =2, fillOpacity = 1, color = 'darkblue', r
        adius = 5, opacity = 1, group = "Government structure", popup = gov_dslums$details, options = popupOpti
        ons(keepInView = TRUE)) %>%
  addCircleMarkers(lng = plg_dslums$lng, lat = plg_dslums$lat, weight =2, fillOpacity = 1, color = 'maroon', rad
        ius = 10, opacity = 1, group = "Playground", popup = plg_dslums$details, options = popupOptions(keepInV
        iew = TRUE)) %>%
  addCircleMarkers(lng = cmc_dslums$lng, lat = cmc_dslums$lat, weight =2, fillOpacity = 1, color = 'orange', rad
        ius = 10, opacity = 1, group = "Community center", popup = cmc_dslums$details, options = popupOptions(k
        eepInView = TRUE)) %>%
  addCircleMarkers(lng = clb_dslums$lng, lat = clb_dslums$lat, weight =2, fillOpacity = 1, color = 'blueviolet',
        radius = 5, opacity = 1, group = "Community club", popup = clb_dslums$details, options = popupOptions(k
        eepInView = TRUE)) %>%
  addCircleMarkers(lng = bzr_dslums$lng, lat = bzr_dslums$lat, weight =2, fillOpacity = 1, color = '#00CC66', ra
        dius = 5, opacity = 1, group = "Bazar", popup = bzr_dslums$details, options = popupOptions(keepInView =
        TRUE)) %>%
  addCircleMarkers(lng = wst_dslums$lng, lat = wst_dslums$lat, weight =2, fillOpacity = 1, color = 'darkred', ra
        dius = 5, opacity = 1, group = "Waste disposal point", popup = wst_dslums$details, options = popupOptio
        ns(keepInView = TRUE)) %>%
  addCircleMarkers(lng = epa_dslums$lng, lat = epa_dslums$lat, weight =2, fillOpacity = 1, color = '#009999', ra
        dius = 5, opacity = 1, group = "Eviction prone area", popup = epa_dslums$details, options = popupOption
        s(keepInView = TRUE)) %>%
  addCircleMarkers(lng = fpa_dslums$lng, lat = fpa_dslums$lat, weight =2, fillOpacity = 1, color = '#0000FF', ra
        dius = 5, opacity = 1, group = "Fire prone area", popup = fpa_dslums$details, options = popupOptions(ke
        epInView = TRUE)) %>%
  addCircleMarkers(lng = poe_dslums$lng, lat = poe_dslums$lat, weight =2, fillOpacity = 1, color = '#00FF00', ra
        dius = 5, opacity = 1, group = "Place of entertainment", popup = poe_dslums$details, options = popupOpt
        ions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = usz_dslums$lng, lat = usz_dslums$lat, weight =2, fillOpacity = 1, color = '#FF00CC', ra
        dius = 5, opacity = 1, group = "Unsafe zone", popup = usz_dslums$details, options = popupOptions(keepIn
        View = TRUE)) %>%
  addCircleMarkers(lng = wla_dslums$lng, lat = wla_dslums$lat, weight =2, fillOpacity = 1, color = '#333033', ra
        dius = 5, opacity = 1, group = "Waterlogging area", popup = wla_dslums$details, options = popupOptions(
        keepInView = TRUE)) %>%
  #fitBounds(lng1 = min(dholpur_slum$lng), lat1 = min(dholpur_slum$lat), lng2 = max(dholpur_slum$lng), lat2 = ma
        x(dholpur_slum$lat)) %>%
  addMiniMap(toggleDisplay = TRUE, tiles = providers$OpenStreetMap) %>%
  #addGraticule(group = "Graticule", interval = 0.02, style = list(color = "#FF0000", weight = 1)) %>%
  addLayersControl(baseGroups = c("Open SM", "Toner Lite", "World Imagery"), options = layersControlOptions(coll
        apsed = FALSE),
                   overlayGroups = c("Dholpur slum boundary",
                                     #"Graticule",
                                     "Pharmacy with(out) doctor",
                                     "Drinking water collection point",
```

```
                                    "Toilet and washing point",
                                    "School or learning center",
                                    "Mosque or Temple",
                                    "Government structure",
                                    "Playground",
                                    "Community center",
                                    "Community club",
                                    "Community club",
                                    "Bazar",
                                    "Waste disposal point",
                                    "Eviction prone area",
                                    "Fire prone area",
                                    "Place of entertainment",
                                    "Unsafe zone",
                                    "Waterlogging area")) %>%
  hideGroup(c(#"Pharmacy with(out) doctor",
    "Drinking water collection point",
    "Toilet and washing point",
    "School or learning center",
    "Mosque or Temple",
    "Government structure",
    "Playground",
    "Community center",
    "Community club",
    "Community club",
    "Bazar",
    "Waste disposal point",
    "Eviction prone area",
    "Fire prone area",
    "Place of entertainment",
    "Unsafe zone",
    "Waterlogging area")) %>%
  addControl('<a rel="license" href="http://creativecommons.org/licenses/by-nc-sa/4.0/">
              <img alt="Creative Commons License" style="border-width:0" src="https://i.creativecommons.org/l/by-
        nc-sa/4.0/88x31.png" /></a>',
              position = "bottomleft")%>%
  addMeasure(
    position = 'bottomleft',
    primaryLengthUnit = 'meters',
    primaryAreaUnit = 'sqmeters',
    activeColor = '#3D535D',
    completedColor = '#7D4479')
```

1.6.6 Creating Leaflet map: Shyampur

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```
shyampur_slum_map <- shyampur_slum %>%
  leaflet::leaflet() %>%
  addProviderTiles(providers$Esri.WorldImagery, group = "World Imagery") %>%
  addProviderTiles(providers$Stamen.TonerLite, group = "Toner Lite") %>%
  addProviderTiles(providers$OpenStreetMap, group = "Open SM") %>%
  addPolygons(data = outline_s, lng = outline_s$lng, lat = outline_s$lat, fill = FALSE,
              weight = 4, color = "blue", opacity = 1, group = "Dholpur slum boundary") %>%
  addCircleMarkers(lng = hcf_sslums$lng, lat = hcf_sslums$lat, weight = 2,
                   fillOpacity = 1, color = 'red', radius = 5, opacity = 1,
                   group = "Pharmacy with(out) doctor", popup = hcf_sslums$Facilities,
                   options = popupOptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = wcp_sslums$lng, lat = wcp_sslums$lat, weight = 2,
                   fillOpacity = 1, color = 'black', radius = 5, opacity = 1,
                   group = "Drinking water collection point", popup = wcp_sslums$Facilities,
                   options = popupOptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = saf_sslums$lng, lat = saf_sslums$lat, weight = 2,
                   fillOpacity = 1,  color = 'green', radius = 5, opacity = 1,
                   group = "Toilet and washing point", popup = saf_sslums$Facilities,
                   options = popupOptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = edi_sslums$lng, lat = edi_sslums$lat, weight = 2,
                   fillOpacity = 1,  color = 'cyan', radius = 5, opacity = 1,
                   group = "School or learning center", popup = edi_sslums$Facilities,
                   options = popupOptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = rep_sslums$lng, lat = rep_sslums$lat, weight =2,
                   fillOpacity = 1, color = 'purple', radius = 5, opacity = 1,
                   group = "Mosque or Temple", popup = rep_sslums$Facilities,
                   options = popupOptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = wst_sslums$lng, lat = wst_sslums$lat, weight =2,
                   fillOpacity = 1, color = 'deeppink', radius = 10, opacity = 1,
                   group = "Waste disposal point", popup = wst_sslums$Facilities,
                   options = popupOptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = epa_sslums$lng, lat = epa_sslums$lat, weight =2,
                   fillOpacity = 1, color = '#009999', radius = 10, opacity = 1,
                   group = "Eviction prone area", popup = epa_sslums$Facilities,
                   options = popupOptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = fpa_sslums$lng, lat = fpa_sslums$lat, weight =2,
                   fillOpacity = 1, color = '#0000FF', radius = 10, opacity = 1,
                   group = "Fire prone area", popup = fpa_sslums$Facilities,
                   options = popupOptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = poe_sslums$lng, lat = poe_sslums$lat, weight =2,
                   fillOpacity = 1, color = '#00FF00', radius = 10, opacity = 1,
                   group = "Place of entertainment", popup = poe_sslums$Facilities,
                   options = popupOptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = usz_sslums$lng, lat = usz_sslums$lat, weight =2,
                   fillOpacity = 1, color = '#FF00CC', radius = 5, opacity = 1,
                   group = "Unsafe zone", popup = usz_sslums$Facilities,
                   options = popupOptions(keepInView = TRUE)) %>%
  addCircleMarkers(lng = wla_sslums$lng, lat = wla_sslums$lat, weight =2,
                   fillOpacity = 1, color = '#333033', radius = 5, opacity = 1,
                   group = "Waterlogging area", popup = wla_sslums$Facilities,
```

```
                options = popupOptions(keepInView = TRUE)) %>%
#fitBounds(lng1 = min(shyampur_slum$lng), lat1 = min(shyampur_slum$lat),
#          lng2 = max(shyampur_slum$lng), lat2 = max(shyampur_slum$lat)) %>%
addMiniMap(toggleDisplay = TRUE, tiles = providers$OpenStreetMap) %>%
#addGraticule(group = "Graticule", interval = 0.02, style = list(color = "#FF0000", weight = 1)) %>%
addLayersControl(baseGroups = c("Open SM", "Toner Lite", "World Imagery"),
                 options = layersControlOptions(collapsed = FALSE),
                 overlayGroups = c("Dholpur slum boundary",
                                   #"Graticule",
                                   "Pharmacy with(out) doctor",
                                   "Drinking water collection point",
                                   "Toilet and washing point",
                                   "School or learning center",
                                   "Mosque or Temple",
                                   "Waste disposal point",
                                   "Eviction prone area",
                                   "Fire prone area",
                                   "Place of entertainment",
                                   "Unsafe zone",
                                   "Waterlogging area")) %>%

hideGroup(c(#"Pharmacy with(out) doctor",
  "Drinking water collection point",
  "Toilet and washing point",
  "School or learning center",
  "Mosque or Temple",
  "Waste disposal point",
  "Eviction prone area",
  "Fire prone area",
  "Place of entertainment",
  "Unsafe zone",
  "Waterlogging area")) %>%
addControl('<a rel="license" href="http://creativecommons.org/licenses/by-nc-sa/4.0/">
           <img alt="Creative Commons License" style="border-width:0" src="https://i.creativecommons.org/l/by-
      nc-sa/4.0/88x31.png" /></a>',
           position = "bottomleft")%>%
addMeasure(
  position = 'bottomleft',
  primaryLengthUnit = 'meters',
  primaryAreaUnit = 'sqmeters',
  activeColor = '#3D535D',
  completedColor = '#7D4479')
```

1.6.7 Combining features of three slums

HIDE

```
shyampur <- readr::read_csv("shyampur_slum.csv")
kallayanpur <- readr::read_csv("kallayanpur_slum.csv")
dholpur <- readr::read_csv("dholpur_slum.csv")
shyampur$slum <- "Shyampur"
kallayanpur$slum <- "Kallayanpur"
dholpur$slum <- "Dholpur"
all_three_slum <- rbind(kallayanpur, dholpur, shyampur)
all_three_slum$slum <- factor(all_three_slum$slum, levels = c("Kallayanpur","Dholpur","Shyampur"))
all_three_slum <- dplyr::rename(all_three_slum, Facilities=landmark)
```

HIDE

```
kallayanpur_slum_map
```

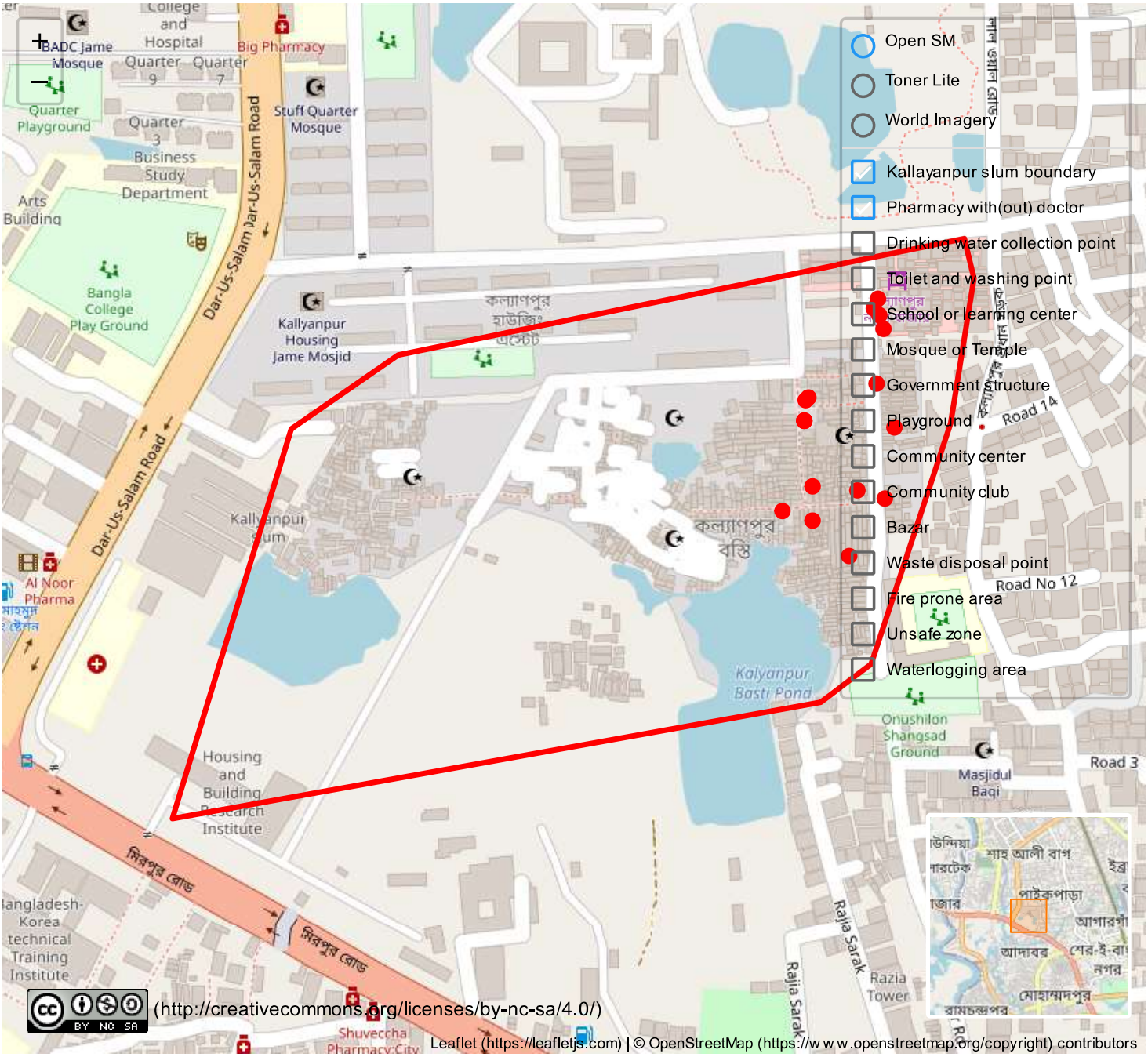

Figure 1: Different health related facilities in Kallayanpur Slum, DSCC, Dhaka City

HIDE

```
dholpur_slum_map
```

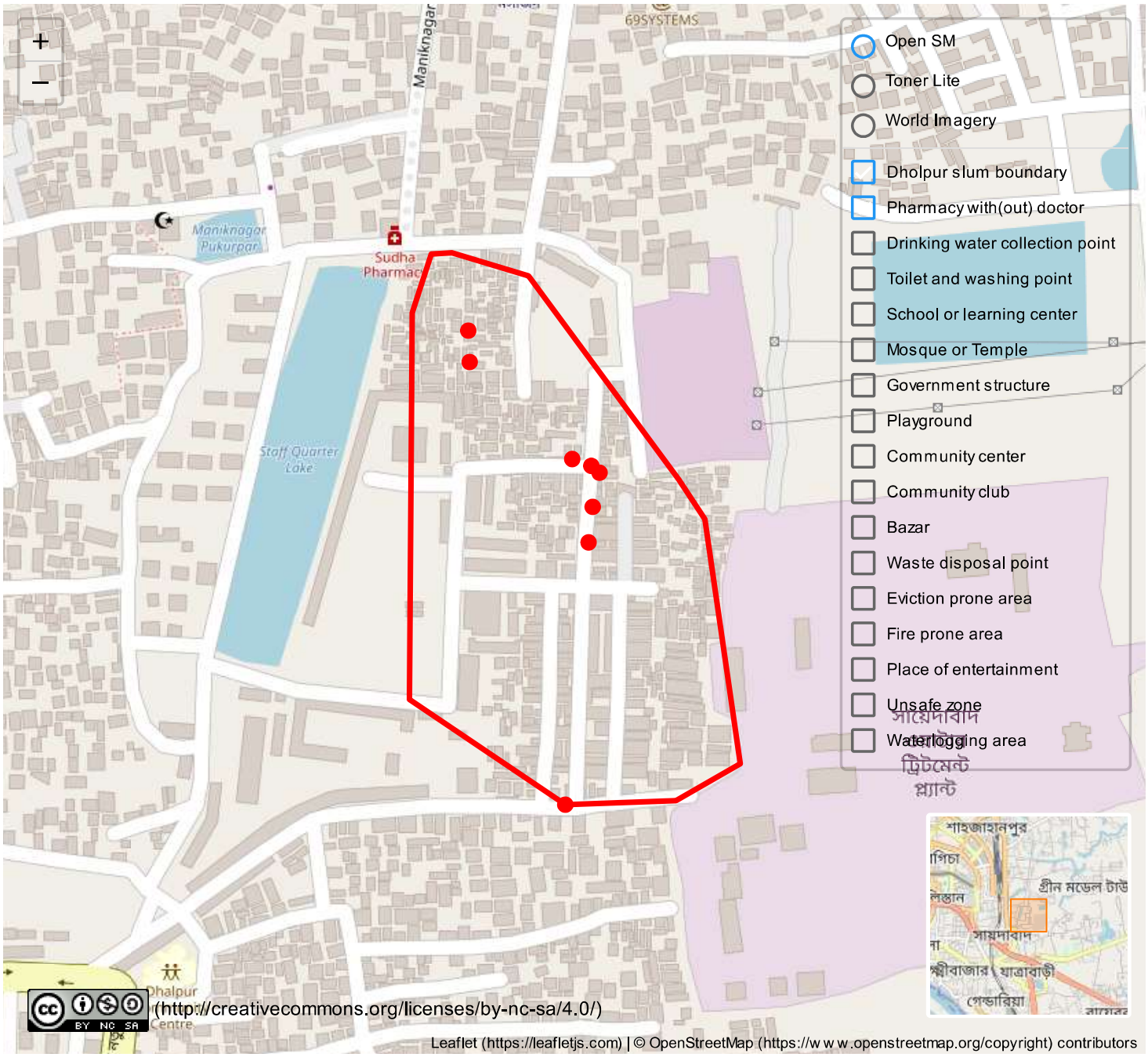

Figure 2: Different health related facilities in Dholpur Slum, DSCC, Dhaka City

HIDE

```
#
```

HIDE

```
shyampur_slum_map
```

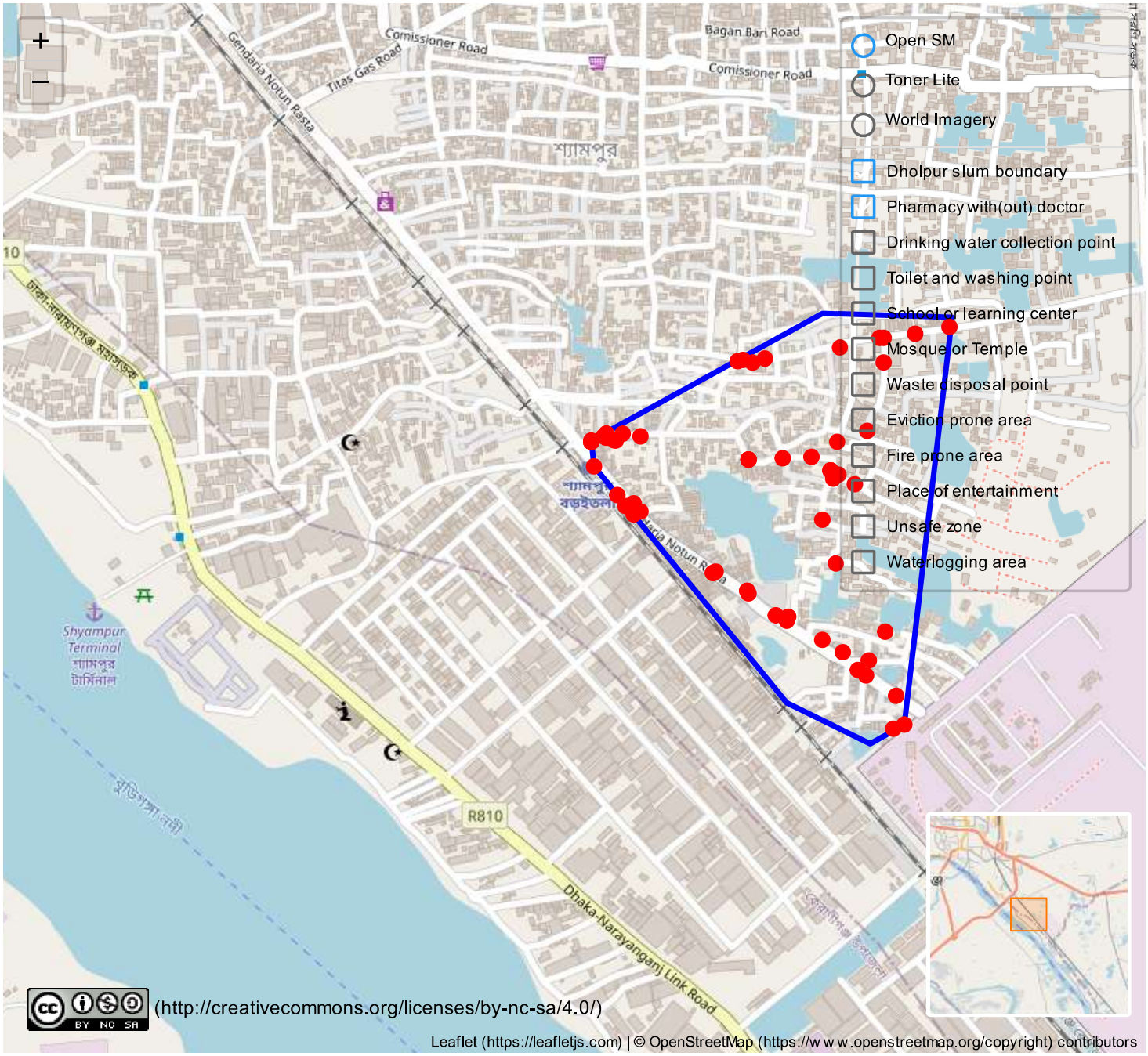

Figure 3: Different health related facilities in Shyampur Slum, DSCC, Dhaka City

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