

## **8. Materials on the Technical Workshop for user of the Project Products**

- 8.1. The Description of Orthophoto imageries
- 8.2. The Instruction for QGIS



**THE DEVELOPMENT OF  
A GEOSPATIAL INFORMATION DATABASE PROJECT IN THE  
REPUBLIC OF ZIMBABWE (Harare Mapping)**

**DIGITAL ORTHOPHOTO  
- What is it and how is it used? -**

**Workshop on the Use of Products from Harare Mapping  
August, 2016**

Japan International Cooperation Agency (JICA)  
Department of the Surveyor General (DSG), Ministry of Lands and Rural Resettlement (MLRR)

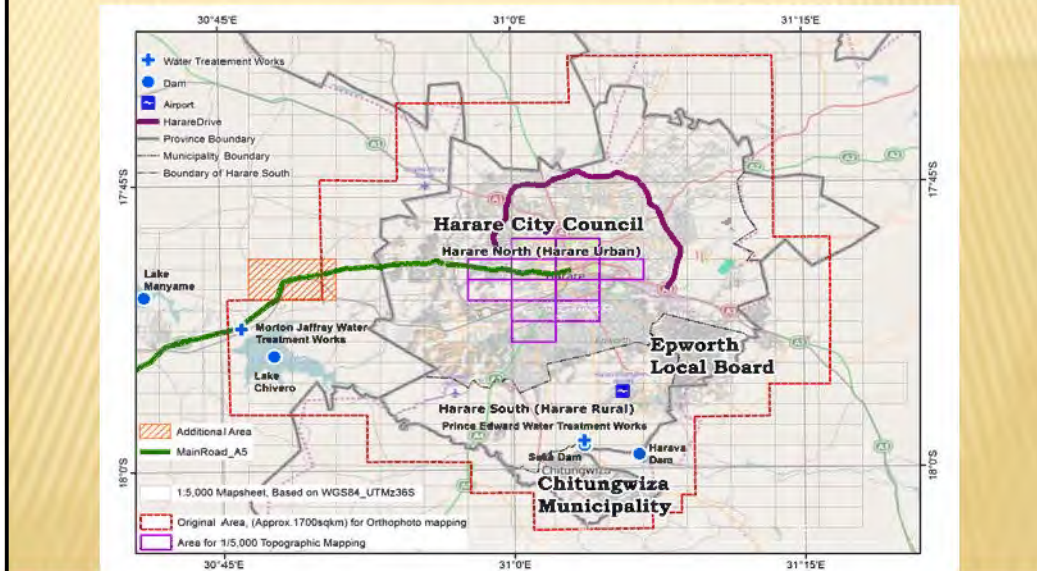
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## INTRODUCTION

- × Outline of Harare Mapping
  - + Project Aims and Objectives
    - × Develop the Geospatial Information Database for the City of Harare and its environs
    - × Capacity Development for DSG
  - + Main Products coming out of the Project
    - × 1:5,000 scale digital topographic maps: approximately 96 km<sup>2</sup>
    - × Digital orthophoto map with contours: approximately 1,700 km<sup>2</sup>

## INTRODUCTION – PROJECT TARGET AREA -



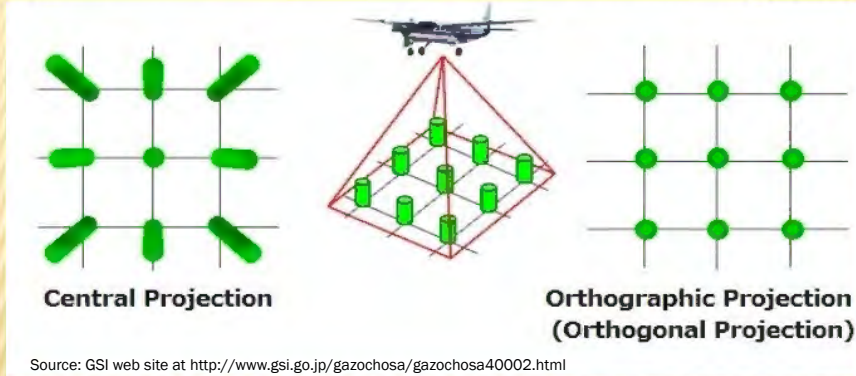
## MAP AND AERIAL PHOTO



Source: GSI web site at <http://www.gsi.go.jp/gazochosa/gazochosa40002.html>

- Base maps such as 1:25,000 and 1:5,000 scale topographic maps are produced from aerial photos

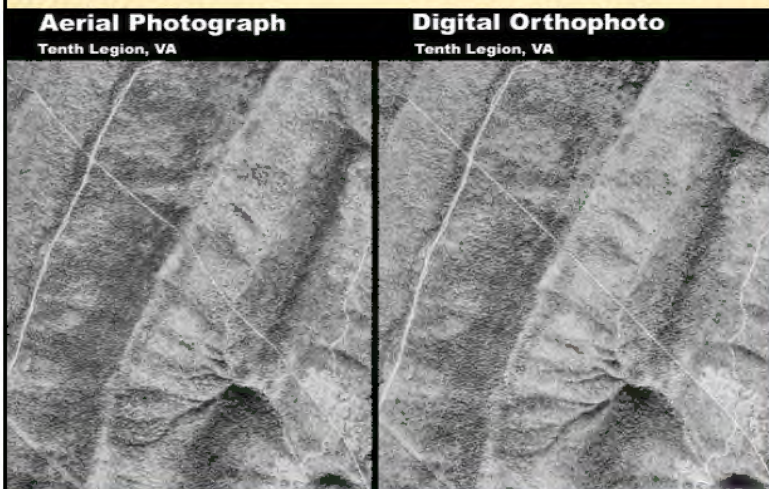
## CENTRAL PROJECTION VS ORTHOGRAPHIC PROJECTION



- **Aerial photos** are 2 dimensional projected images of 3 dimensional real world through central projection.

- **Maps** are 2 dimensional image of real world through orthographic projection.

## WHAT IS DIGITAL ORTHOPHOTO?



- **Aerial photo** contains image displacements caused by tilting of the camera and topography.
- **Orthophoto** is made by removing displacements using camera position & posture and topography (absolute orientation parameters and digital terrain model (DTM))
- In other word, **Orthophoto** is an aerial photo whose projection is changed from **central** to **orthographic** projection. Thus, Orthophoto is exactly overlaid on a map of the same place.

**Orthophoto can be used as a kind of map !!**

Draft specifications

## DIGITAL ORTHOPHOTO OF HARARE MAPPING

✘ Ground resolution: 20 cm

\* Orthophoto is a **raster** data, which is aggregate of cell called "**pixel**".

\* Size of ground corresponding to one pixel is called "**Ground resolution**".



190 x 185



100 x 100



40 x 40



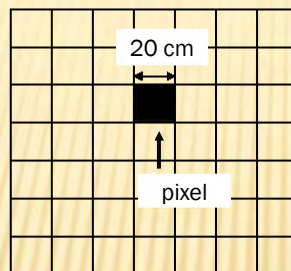
20 x 20



10 x 10



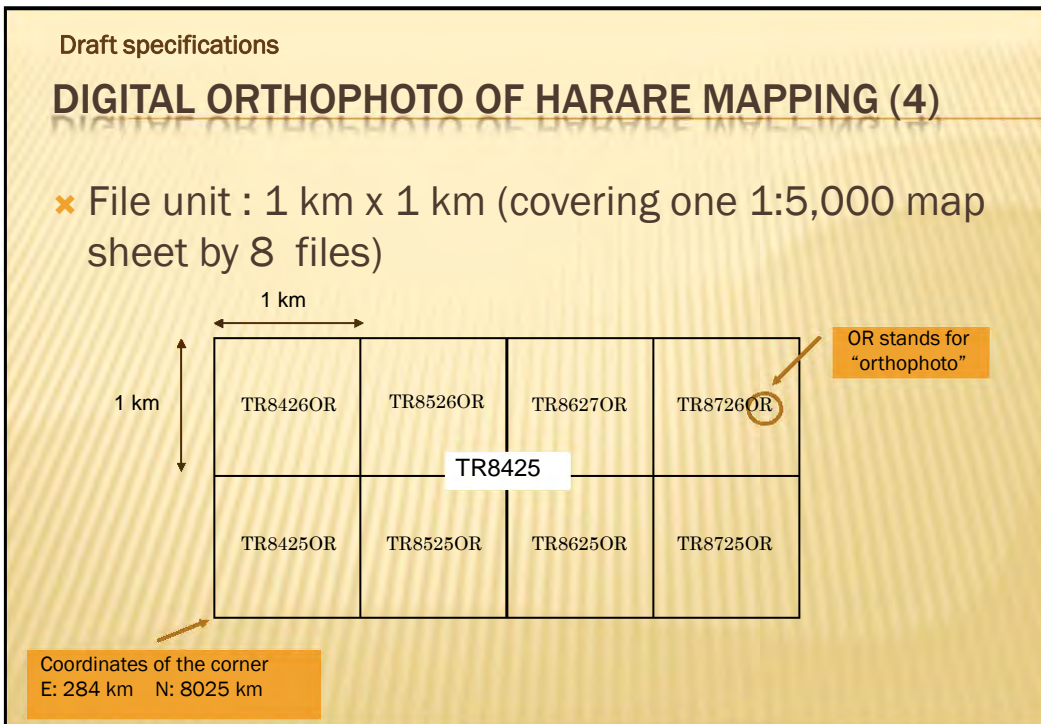
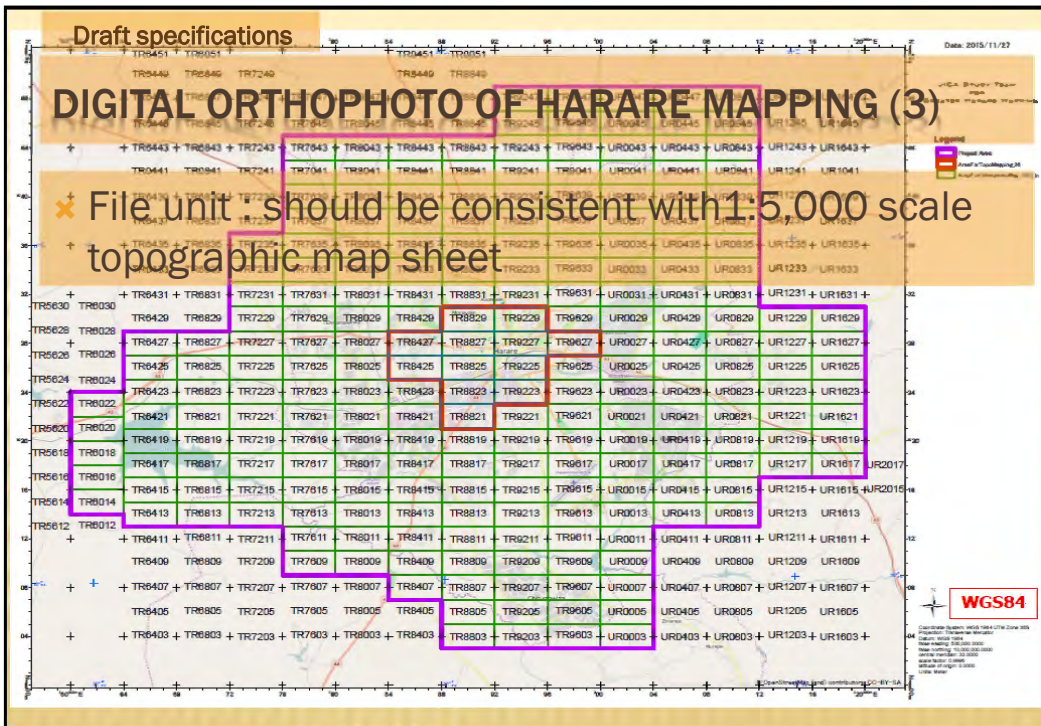
enlarge



Draft specifications

## DIGITAL ORTHOPHOTO OF HARARE MAPPING (2)

- ✘ Geodetic reference system: WGS84
- ✘ Projection: UTM Zone 36S
- ✘ Format: uncompressed and georeferenced Tiff
- ✘ Additional data: contour, geographic names



## DISCUSSION

- ✘ Q&A
- ✘ Group Discussion
  - + Use of digital orthophoto
  - + Request of specifications
  - + others
- ✘ Presentation group by group

## USE OF ORTHOPHOTO

- ✘ Mapping and data collection
  - + Mapping or update of ground objects on the flat areas
  - + Reference material on the field
  - + Understanding of damages caused by disaster
- ✘ Analysis
  - + Background layer in GIS environment
  - + Measure distance and area
- ✘ Planning and Explanation
  - + Use as a base map
  - + Basic materials for planning
  - + Visual material for explanation of the plan



## MAPPING AND DATA COLLECTION



**THE DEVELOPMENT OF  
A GEOSPATIAL INFORMATION DATABASE PROJECT IN THE  
REPUBLIC OF ZIMBABWE (Harare Mapping)**

**Introduction on QGIS**

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**CONTENTS**

- Download and install
- Data input and display
  - Vector data
  - Raster data
  - Project
- Search and extraction
- Adding data (layer)
- Making map and output

## Download and Install Preparation

- Copy the data used in the workshop:
  - From folder named ws\_hararemap in CD or USB to your hard disk
  - Data used in the workshop are as follows:
    - Zimbabwe data which were made from Natural Earth global 1:10m data (<http://www.naturalearthdata.com/downloads/>)
    - Sample data of Harare mapping
    - Folder structure

```
ws_hararemap-----geodata-----zimbabwe
                                     |--hararemap
                                     |
                                     |--work
                                     |
                                     |--materials-----presentation
                                     |
                                     |-----soft
```

## DOWNLOAD and INSTALL

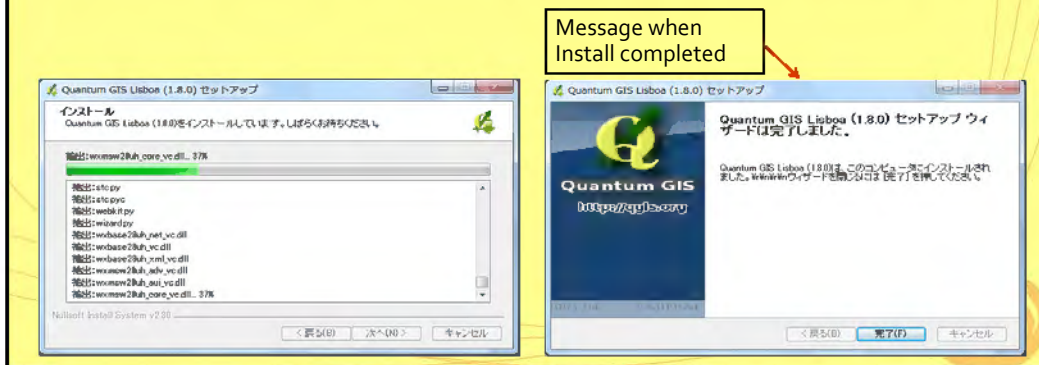
- QGIS
  - A free and open source Geographic Information System



- QGIS can be downloaded from <http://www.qgis.org>
- There are many versions of QGIS. The latest one is version 2.14.3. In this WS, version 1.8.0 is used.
- Older version of QGIS is available at <http://qgis.org/downloads/>

## DOWNLOAD and INSTALL

- To start install QGIS 1.8.0
  - Run QGIS-OSGeo4W-1.8.0-2-Setup.exe
  - check "License agreement", specify "folder to install" and "component to install". Then install start.

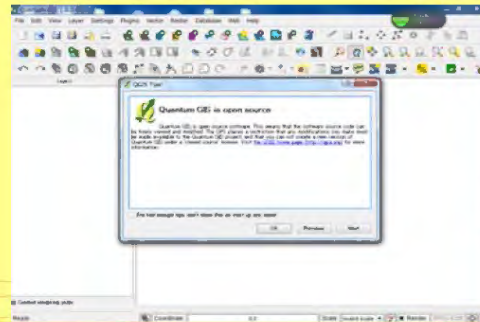


## Data Input and Display

- Here, you learn how to input geospatial data both vector and raster data and display on the screen
- The flow of data input and display
  - Run QGIS
  - Input Vector Layer
    - Specify Input file, coordinate reference system
    - Change parameters for display
      - Color, width of lines
    - Information on attributes
    - Display using attribute
  - Input Raster data
    - How data is Georeferenced?
  - Project file: how to save the work

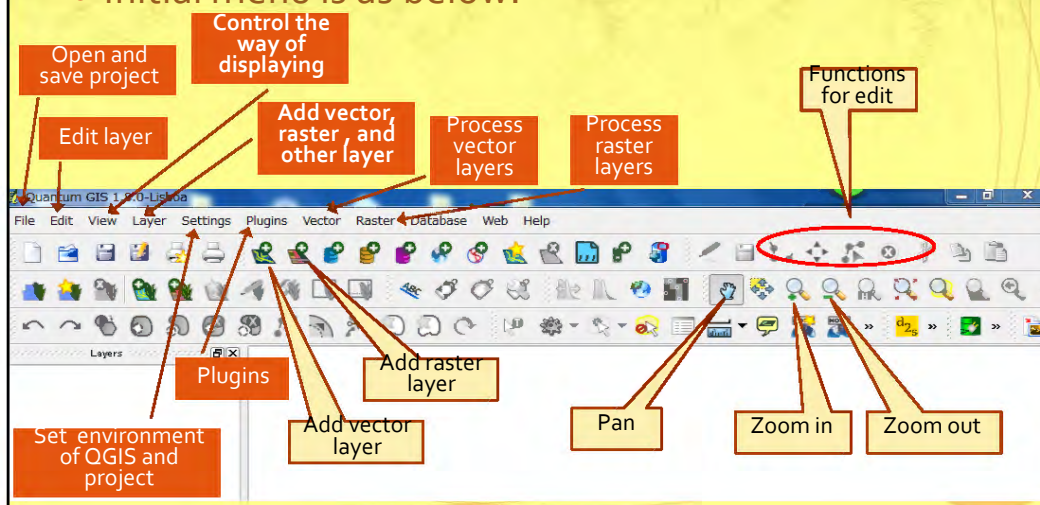
## Data Input and Display Run QGIS

- Run QGIS by double clicking the icon on desktop . Then, the image on the left appears indicating QGIS starts working.
- After some time, QGIS Tips message appears. Press "OK". Then you have an initial view of QGIS.



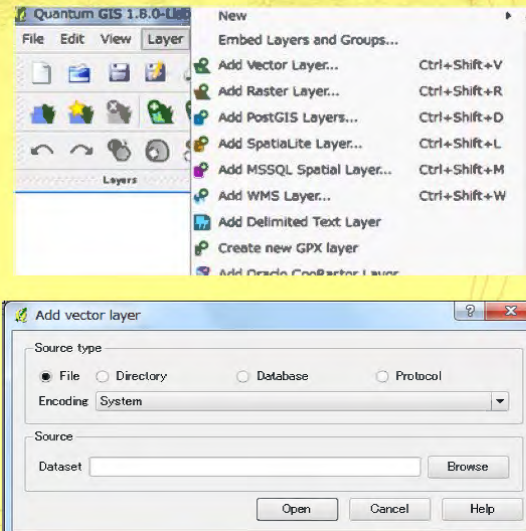
## Data Input and Display Run QGIS

- Initial menu is as below.



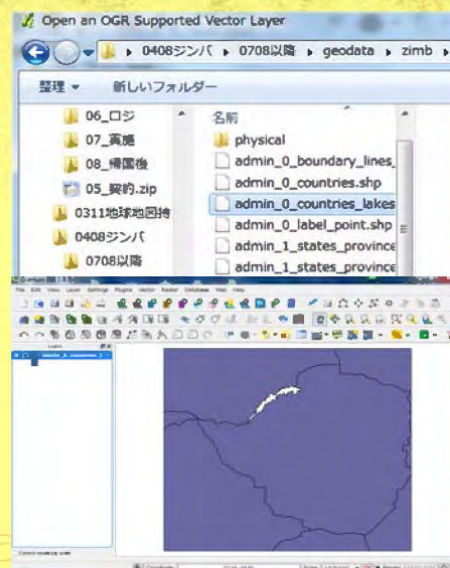
## Data Input and Display Vector Data

- Data expressed as points, lines and polygons
- First, work with "zimbabwe" data
- Click "layer" in the menu and select "Add Vector Layer"
- Then pop up window appears. Click "Browse" and choose .shp file from "zimbabwe" folder.
- .shp file is most commonly used format of vector data



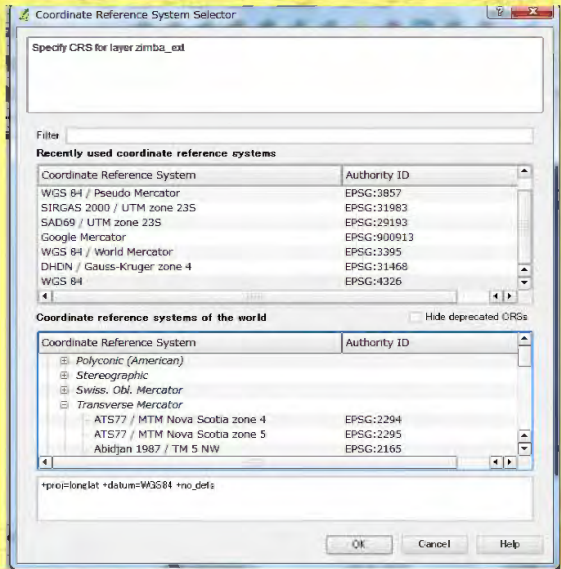
## Data Input and Display Vector Data (2)

- Choose admin\_o\_boundaries\_lake.shp
- Then, national boundary of Zimbabwe and its surrounding countries appears.
- You can zoom-in, zoom-out and pan using icons in the menu bar



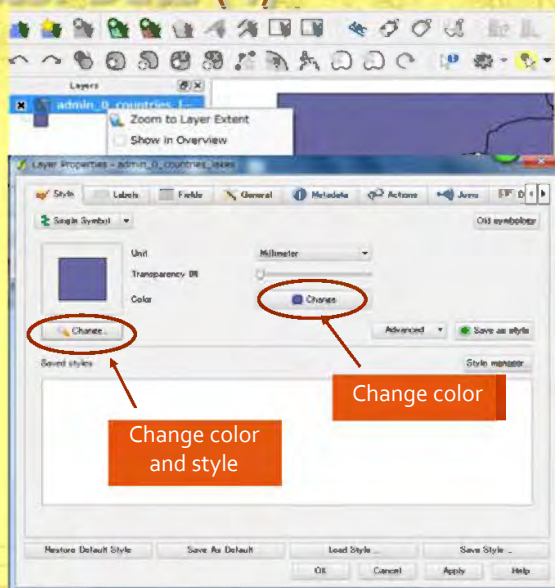
## Data Input and Display Vector Data (3)

- You may be asked to specify coordinate reference system. Ellipsoid and projection must be specified.
- In the case of "zimbabwe" data, ellipsoid and projection is already specified by .prj file
- .shp file at least consists of 3 files (.shp, .shx, .dbf). If .prj file does not exist, this menu appears and you have to specify ellipsoid and projection.
- "zimbabwe" data are based on geographic coordinate (lat, lon) and WGS84.



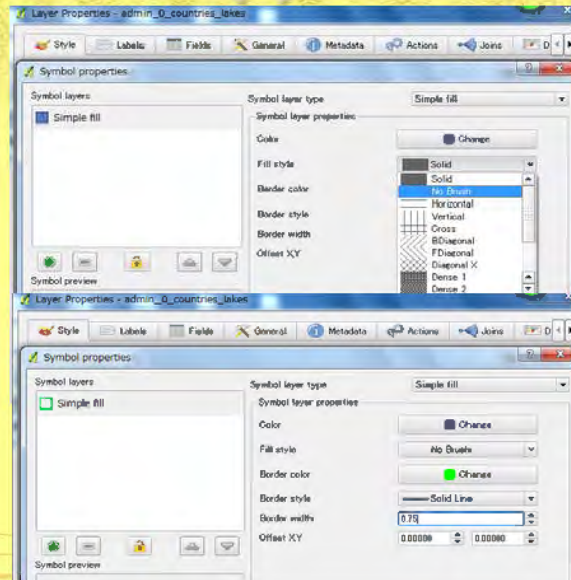
## Data Input and Display Vector Data (4)

- You can change the way data displayed.
- First, select layer in the layer panel and right click, and choose "property".
- Layer property window appears. Select Style tab, if necessary.




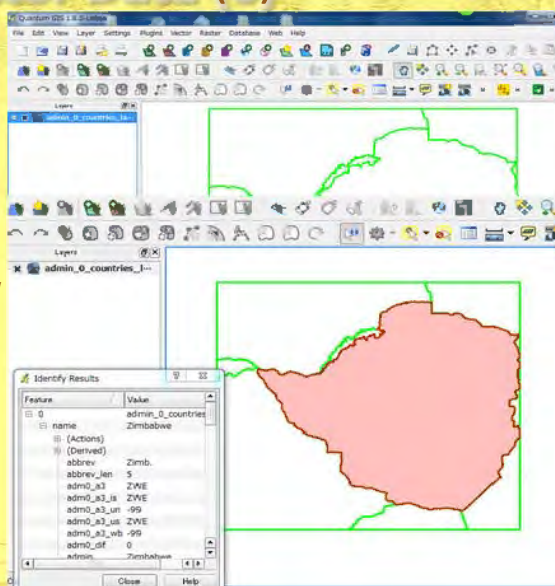
## Data Input and Display Vector Data (5)

- If you click "change" button in the left, Symbol properties menu appears, in which you can change style and color of the layer.
- In this case, layer is polygon, so you can change fill style, border color, style & width.
- Here, set the parameters as shown in the right.



## Data Input and Display Vector Data (6)

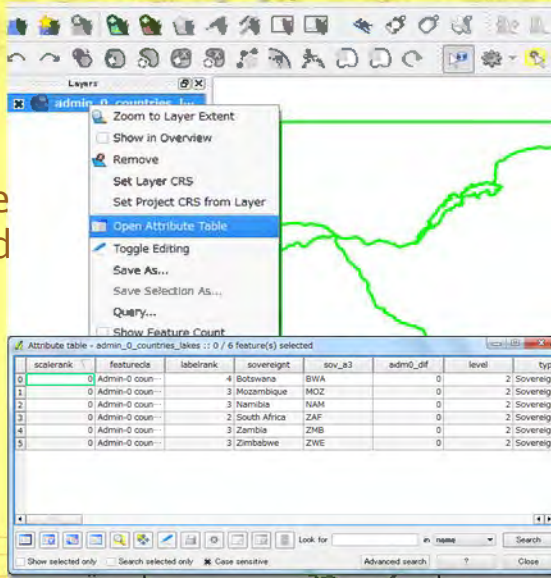
- Press Ok twice, then the national boundaries are shown as specified.
- We can see attributes of the layer by selecting  icon, and click some point of layer. In this case, click the inside Zimbabwe.
- Then, window showing attributes of the polygon shaping Zimbabwe appears.





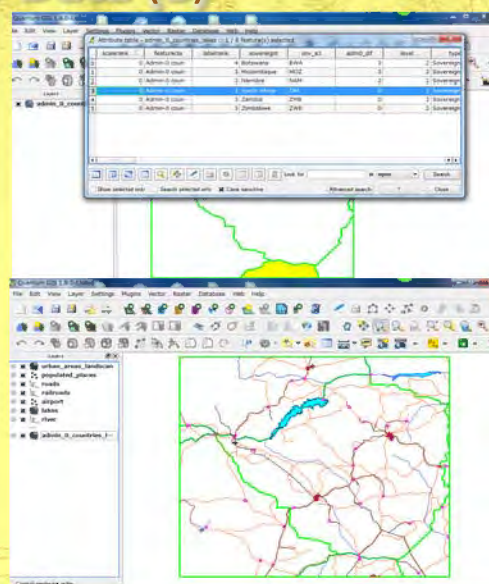
## Data Input and Display Vector Data (7)

- To look at all the attributes, point the layer, right click and select "Open Attribute Table" in the appeared menu.
- Table showing the attributes of all polygons (in this case) appears.



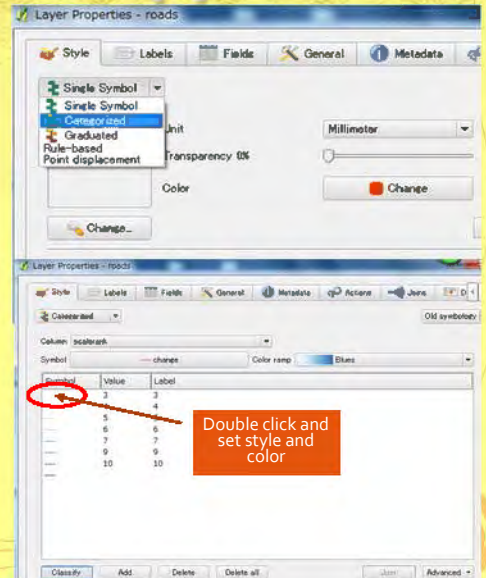
## Data Input and Display Vector Data (8)

- If you point some record (row), selected feature (country in this case) is highlighted in yellow color.
- Now, you add other layers river, lakes, airports, railroads, roads, populated places, urban area as the same way you did for national boundaries.
- Results is not attractive. For example, main roads and minor roads are shown in the same way.



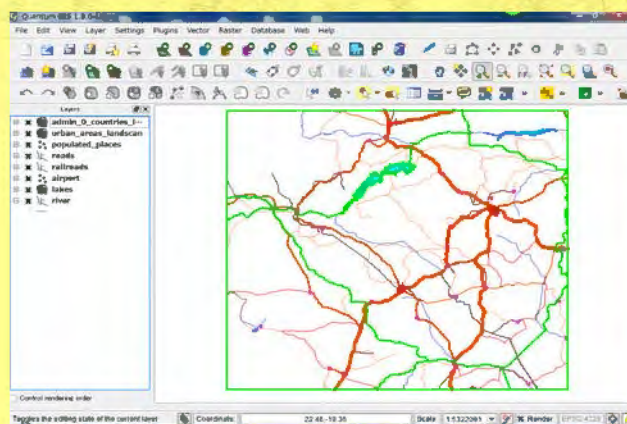
## Data Input and Display Vector Data (9)

- Better way of displaying roads using attribute showing rank of road.
- Point road layer and right click and select "properties".
- In the layer properties menu, select "Categorized". And set attribute showing rank of road at the "Column" parameter. In this case choose "scale rank". After this, push "Classify" button.
- Then set parameters of style and color of the road of each rank.



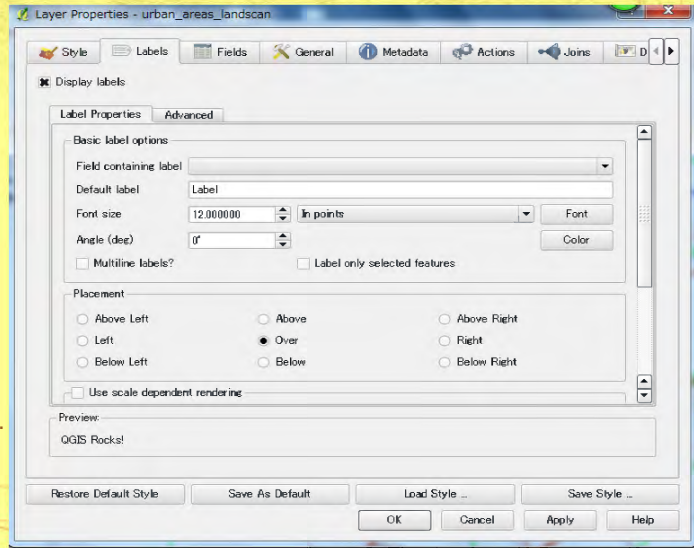
## Data Input and Display Vector Data (10)

- Here is the result. We can see the structure of road network better than before.



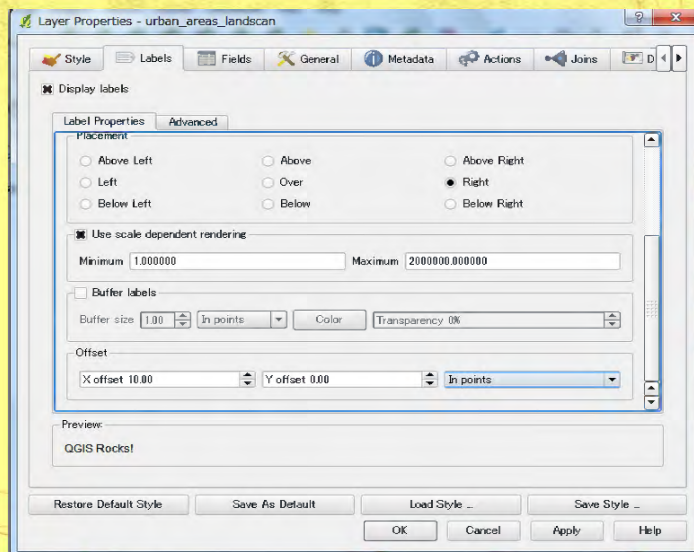
## Data Input and Display Vector Data (11)

- Now what is missing is annotation. Let's put name of cities.
- Point "urban areas" layer, right click, select "properties" and choose Labels tag in the appeared menu.
- Check "Display labels" in the upper left corner.
- Set parameters such as Field containing label, Font (type, size, color), and Placement.



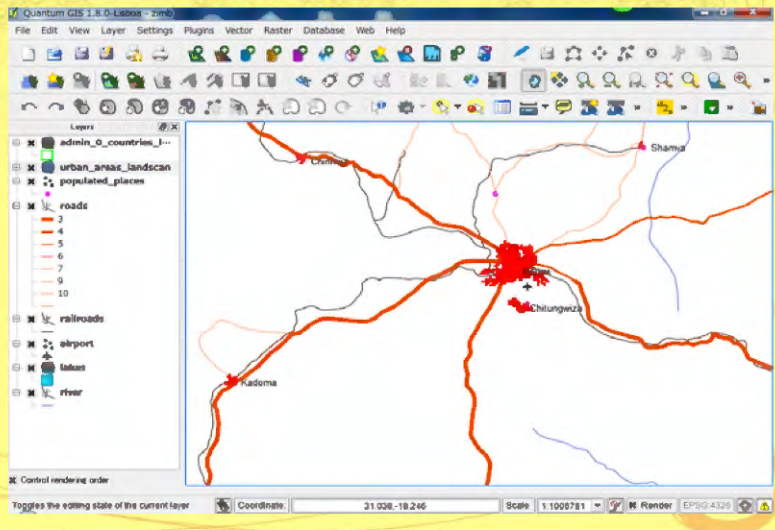
## Data Input and Display Vector Data (12)

- If you down the scroll bar at the right side, you can see the parameter for scale dependent labeling. This is to avoid confusion by showing too many annotation in the map when you zoom out the map.



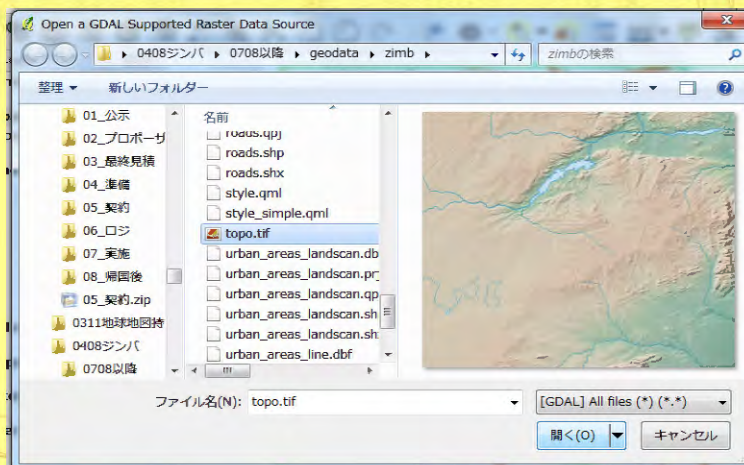
## Data Input and Display Vector Data (12)

- Here is the result around the city of Harare.



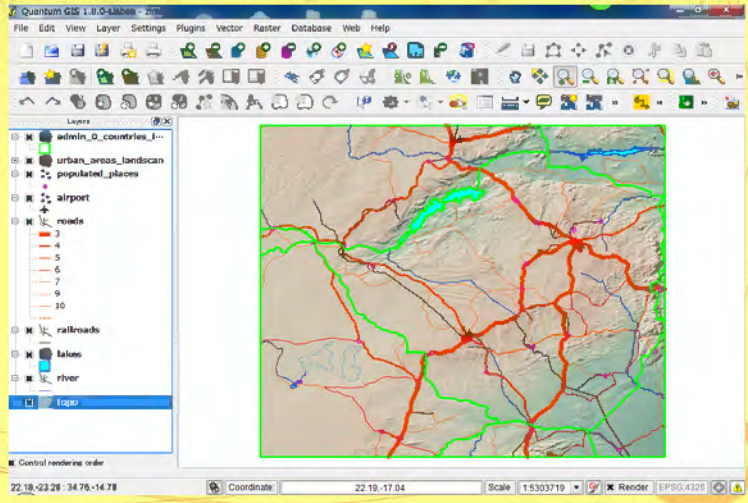
## Data Input and Display Raster Data

- Click "layer" in the menu and select "Add Raster Layer".
- Then pop up window appears to select raster data. Here choose "topo.tif" from "zimbabwe" folder.



## Data Input and Display Raster Data (2)

- Here is the result.  
topo.tif is put the bottom in the Layer panel so that vector layers can be seen.



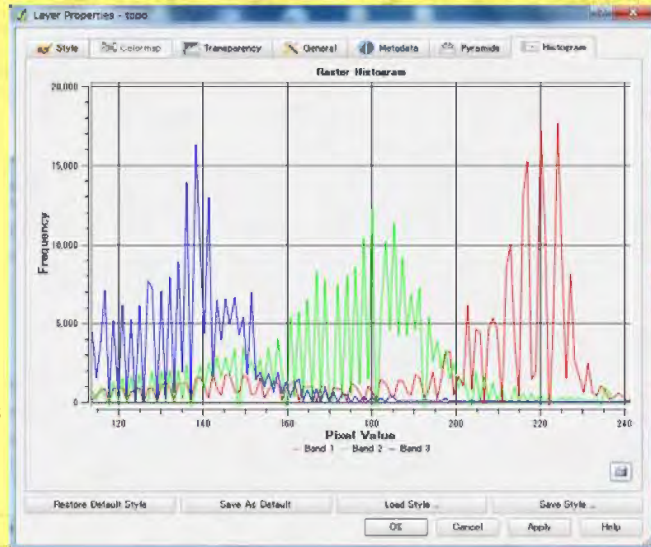
## Data Input and Display Raster Data (3)

- Georeference
  - geotiff
    - Tiff image generally, does not have coordinate information.
    - In the previous example, "topo.tif" is not usual tiff image ,but geotiff image which has its projection and coordinate information inside.
  - .tfw
    - Text file showing pixel size and coordinates of the pixel of upper-left corner in the following format

```
px: ground size of pixel in x direction
0.0
0.0
-py: ground size of pixel in x direction
x: x coordinate of the center of the
pixel in upper-left corner
y: y coordinate of the center of the
pixel in upper-left corner
```
    - If you provide .tfw file with .tif file, QGIS asks you to provide coordinate reference system. Then, tiff image is shown on the screen.

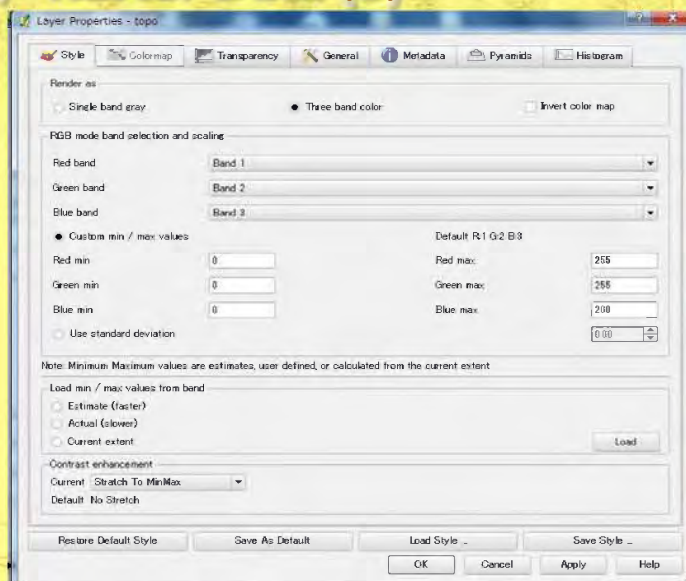
## Data Input and Display Raster Data (4)

- Image enhancement
  - Stretch using min&max or standard deviation
  - Take "topo.tif" in zimbabwe data as an example. Point "topo.tif", right click and select properties. Then, select Histogram tab. You can get the histogram shown in the right. Here, pixel value of blue band almost less than 200.



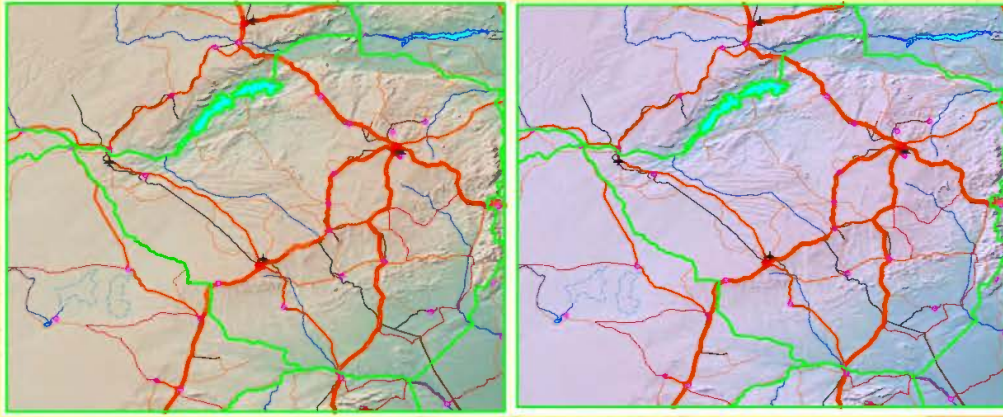
## Data Input and Display Raster Data (5)

- Then, choose Style tab, and set parameters as follows:
  - 200 for Blue max in Custom min/max values
  - "Stretch To MinMax" in Contrast enhancement
- Then click "Apply" and "OK" buttons at the bottom of the window.



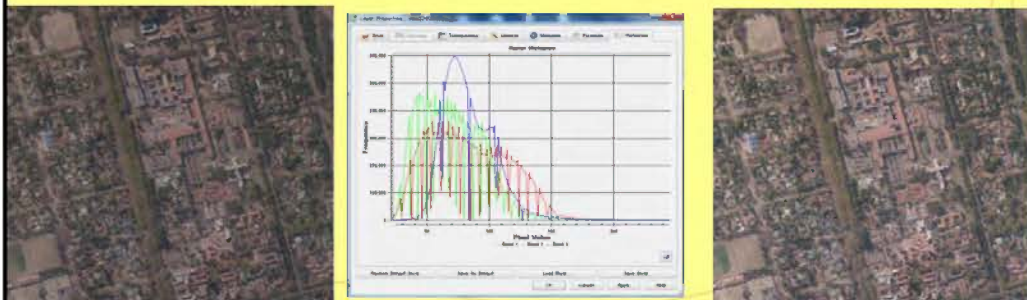
## Data Input and Display Raster Data (6)

- Left image is before enhancement, and right image is after enhancement. As pixel values in blue color are extended, image became more, blueish in the right image.



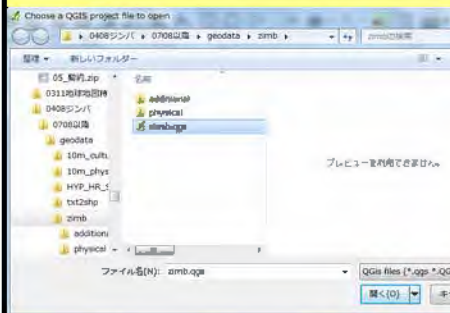
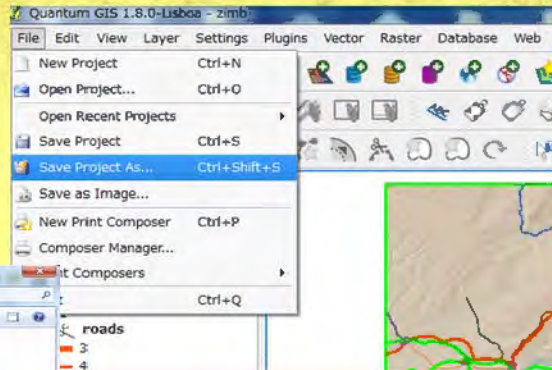
## Data Input and Display Raster Data (7)

- Another example of orthophoto of Harare. As you can see in the histogram, max pixel values in all R,G and B colors are less than 200.
- So, pixel values in R,G and B colors are stretched from 200 top 255. That makes image brighter



## Data Input and Display Save Project

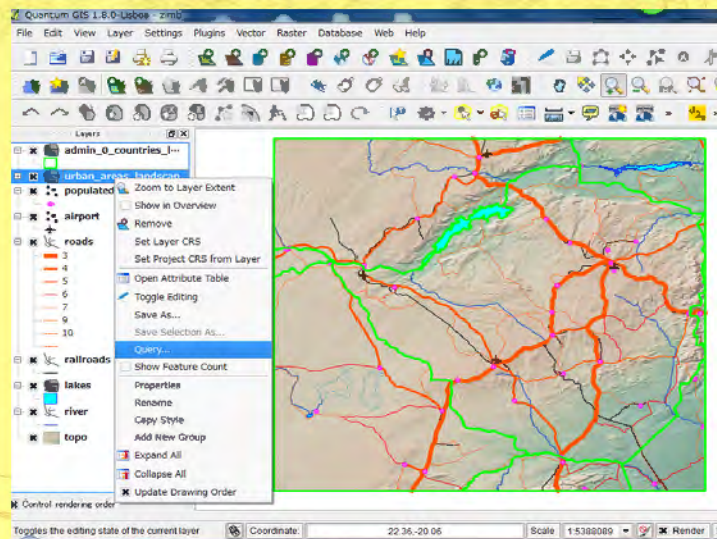
- To keep the works you made, click "File", select "Save Project As" and save the project file.
- To avoid the loss of your work it is better to save your work from time to time even in the middle of your work.



- To view or restart your work later, click "File", select "Open Project" and choose the project file in the appeared window. Then, the situation when you save the project last is displayed on the screen.
- To finish QGIS, click "File" and select "Exit"

## Search and Extraction

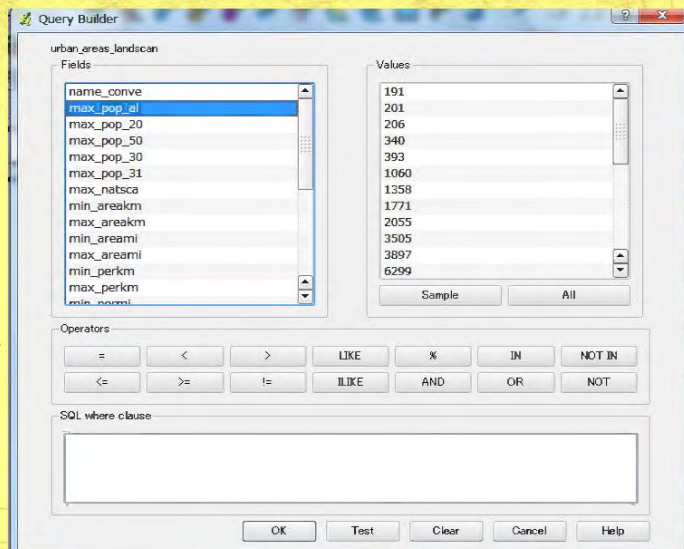
- QGIS has various function. Among them, search and extraction functions are introduced here. This means search specific objects and extract them as a geospatial data.
- Here, try to search cities whose populations are more than 1million.
- First, point "urban area land scan", right click and select "Query".





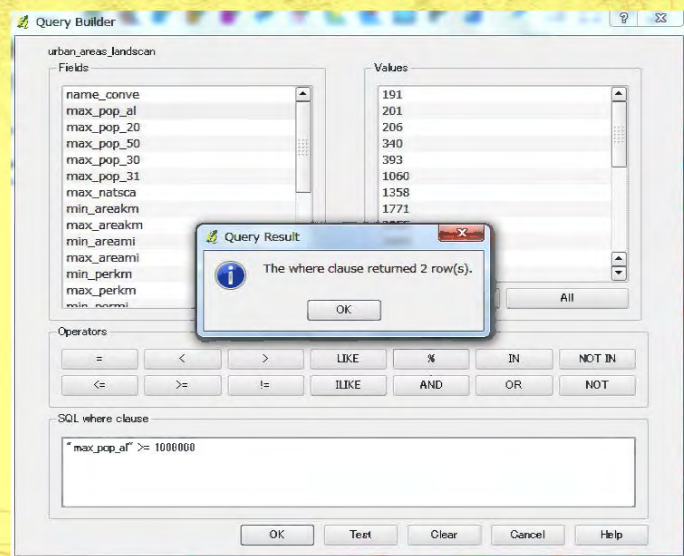
## Search and Extraction (2)

- Then, "Query builder" appears. In the upper left side, attributes of "urban area landscan" are shown. "max\_pop\_al" shows the population.
- So, double click "max\_pop\_al" so that this is put in the "SQL where clause" window. Then click ">=" in the Operators area, and input 1000000 in the SQL area.



## Search and Extraction (3)

- Then, click "Test" in the bottom area. In this case, 2 records matched the query. So, click "OK".



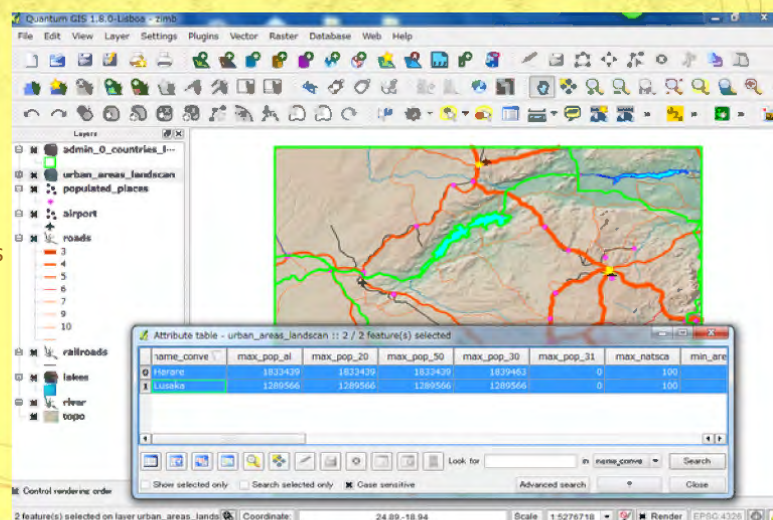
## Search and Extraction (4)

- Nothing happens. So, point "urban area landscan", right click and "Open Attribute Table", where you can find 2 record matched to the query. These are Harare and Lusaka.

	name_conve	max_pop_al	max_pop_20	max_pop_50	max_pop_30	max_pop_31	max_natsca	min_are
0	Harare	1833439	1833439	1833439	1839463	0	100	
1	Lusaka	1289566	1289566	1289566	1289566	0	100	

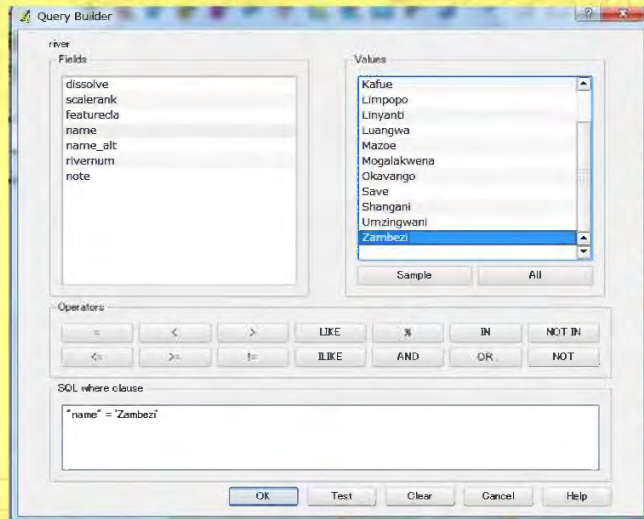
## Search and Extraction (5)

- If you select these two record in the table, these two cities are shown in yellow color on the map.
- If your search is finished, open Query Builder and clear the query if it still exists.



## Search and Extraction (6)

- Now move to theme of finding Zambezi river.
- Point "river" layer, right click and select "Query", then "Query Builder" appears.
- Here we select "name" from Field window, and click "All" in the Value window. Then names of river in this layer appears.
- Then, please put "name" = "Zambezi" in the SQL window, and click "Test" and "OK".



## Search and Extraction (7)

- Then, you can see two records matched to the query by opening the attribute table.

Attribute table - river :: 0 / 2 feature(s) selected

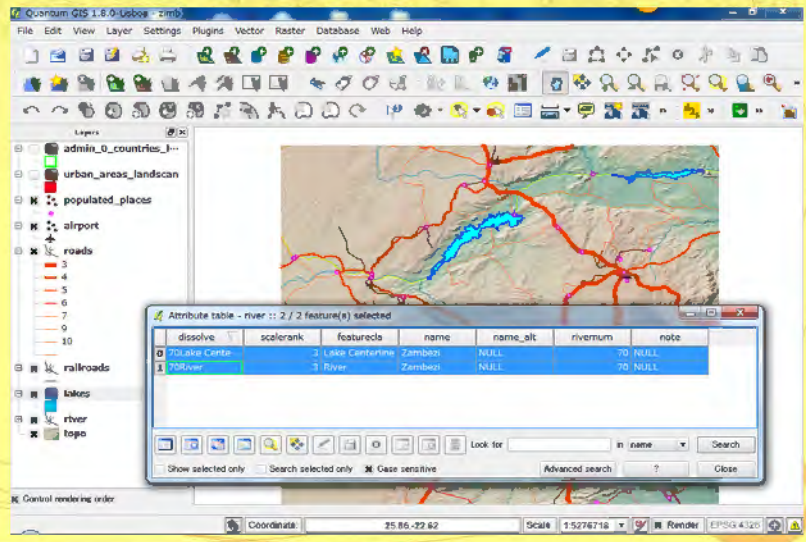
	dissolve	scalerank	featurecla	name	name_alt	rivernum	note
0	70Lake Cente...	3	Lake Centerline	Zambezi	NULL	70	NULL
1	70River	3	River	Zambezi	NULL	70	NULL

Look for  in name Search

Show selected only  Search selected only  Case sensitive Advanced search ? Close

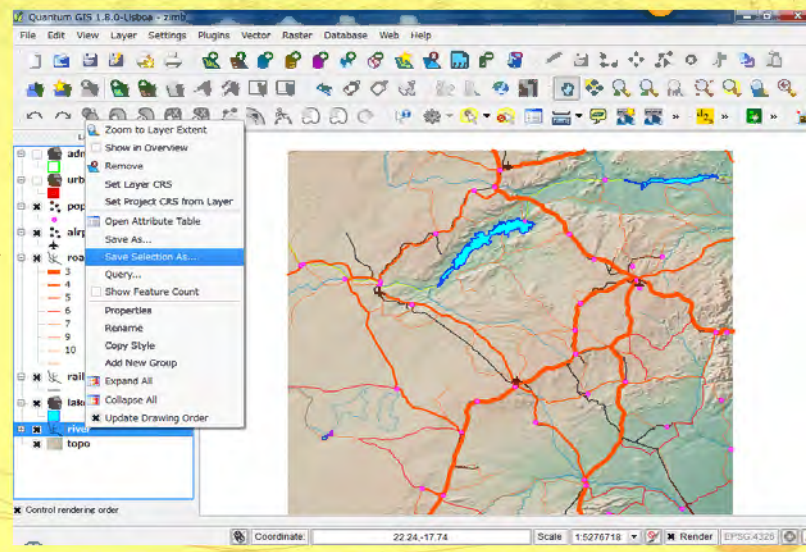
## Search and Extraction (8)

- If you select two records, selected records, they, that is location of Zambezi river, are shown on the map in the yellow color.



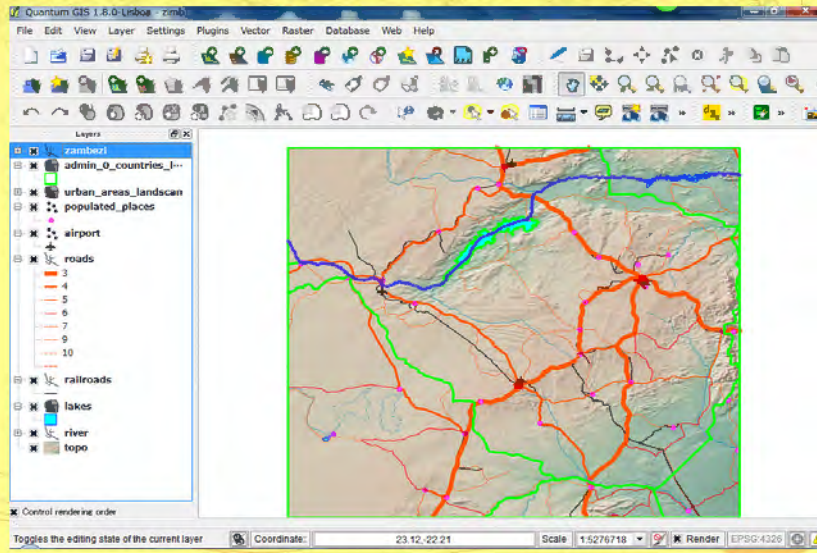
## Search and Extraction (9)

- The searched results can be saved as a .shp file.
- To do that, point "river" layer, right click and select "Save Selection As". Then put the name of the .shp file at the proper location.



## Search and Extraction (10)

- In the right image, you can see the extracted data file named "zambezi" colored in blue color.



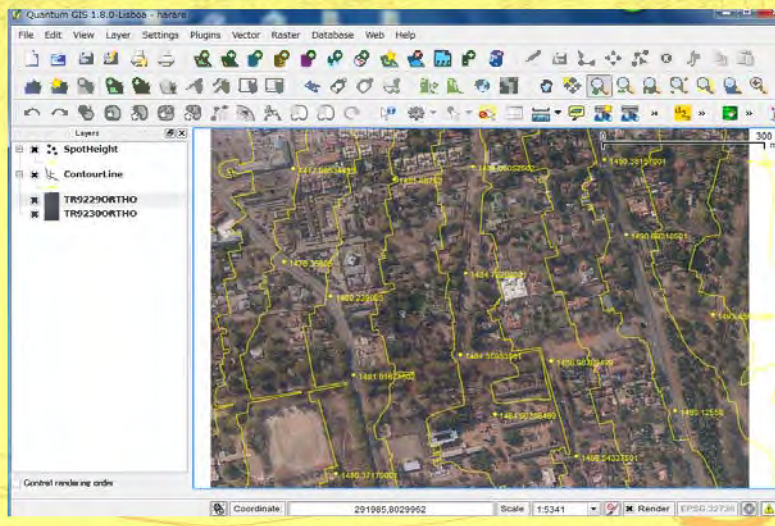
## Adding data (layer)

### -using Harare map orthophoto-

- You can make new layers using QGIS. Here we try to make the point layer of gates of houses as a sample.
- We use sample orthophoto and other vector data in "hararemap" folder. (NB: the orthophoto we use is different the final product in quality).
- We will get locations of gates from visual interpretation roughly, but you need field data collection using orthophoto print or other material in actual work.

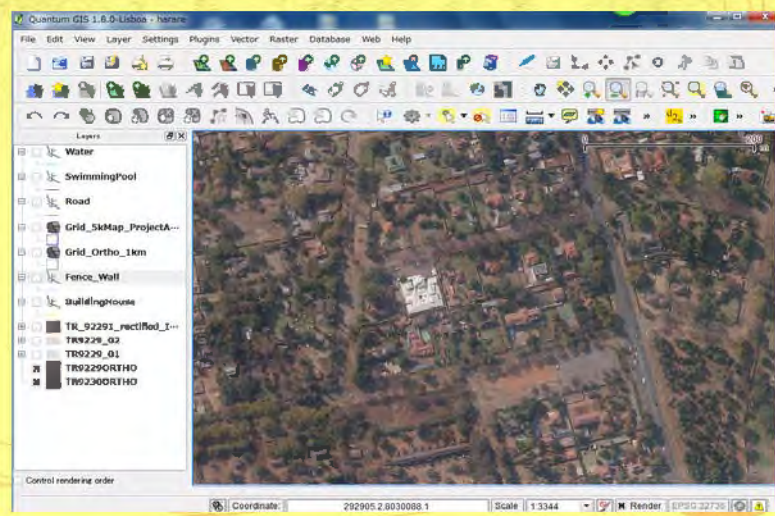
## Adding data (layer) Orthophoto

- Orthophoto in the Harare Mapping is supposed to be provided with contours, spot heights and some place name.
- First, orthophoto and other vector data are input and displayed using QGIS. And put it proper project name such as harare.qgs



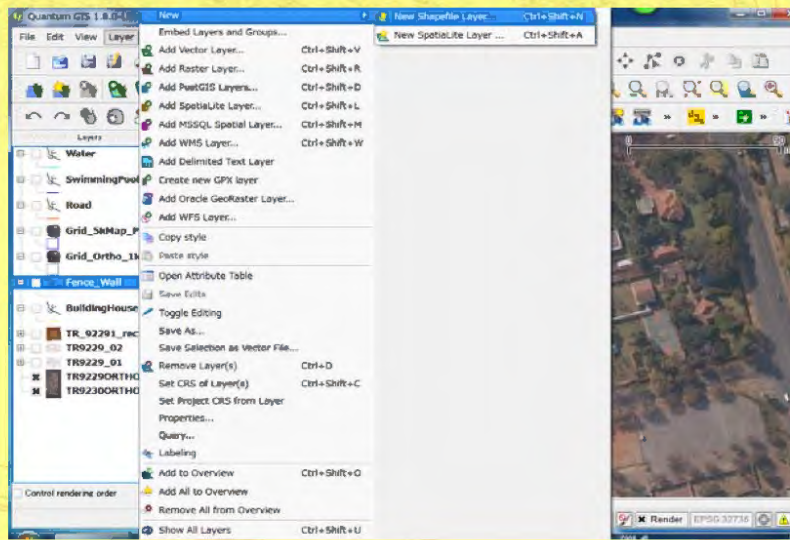
## Adding data (layer) Orthophoto (2)

- Select appropriate place for practice.



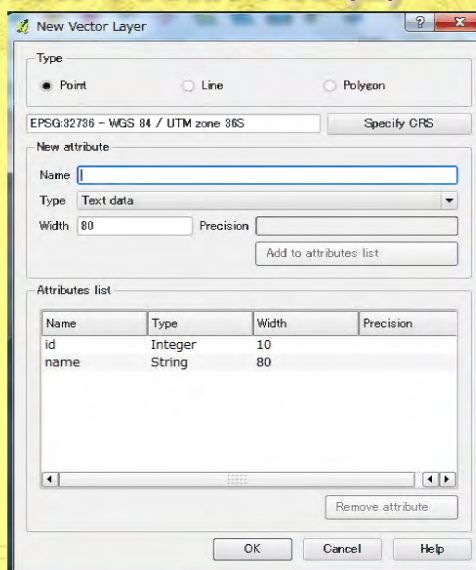
## Adding data (layer) Create New Vector File

- To create a new vector file for gates of houses, click "Layer", select "New" and "New Shapefile Layer".



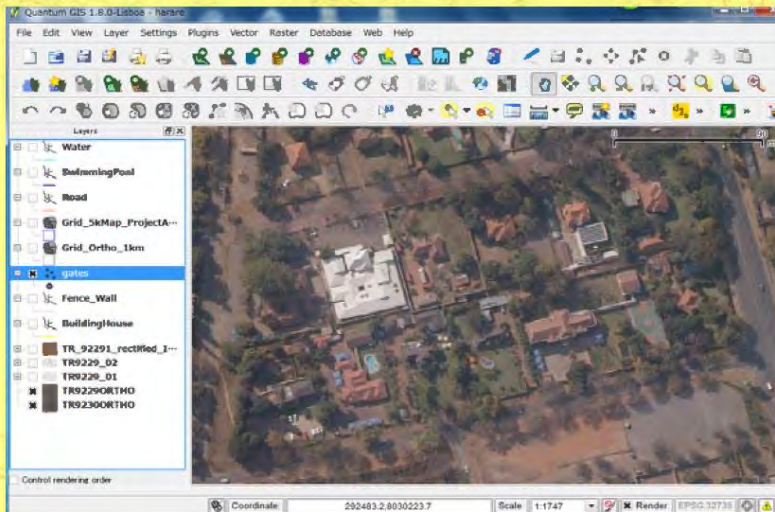
## Adding data (layer) Create New Vector File (2)

- Then, a new window appears where "Type", "CRS", information on new attributes should be specified.
- For a new attribute, "Name", "Type" (e.g. text, integer, etc) and "Width" are specified and click "Add to attribute list", then the new attribute appears in the Attribute list box in the bottom half.
- After adding necessary attribute, press "Ok". Then another window appears to ask you to put the name of new layer.



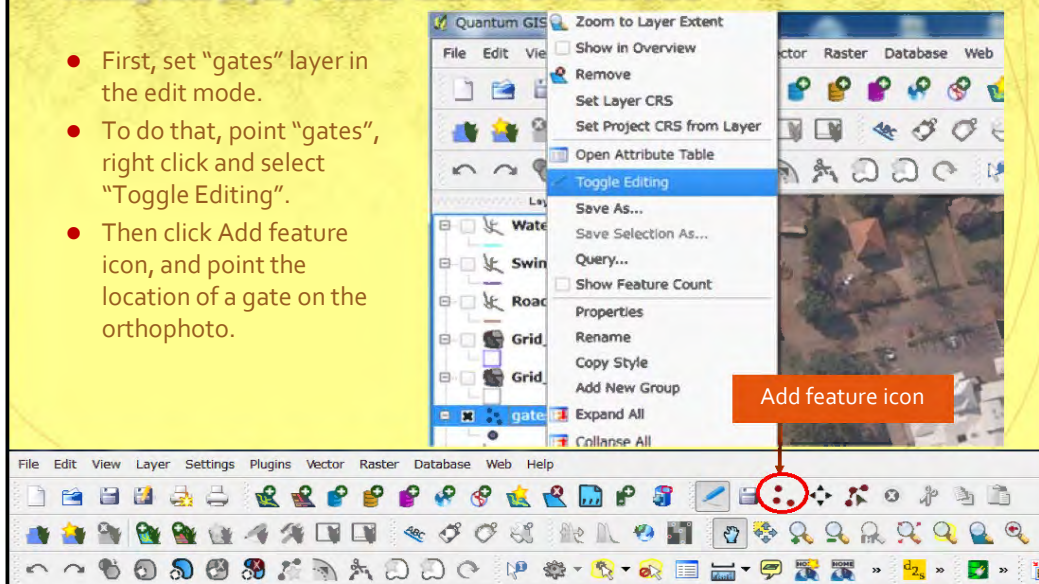
## Adding data (layer) Create New Vector File (3)

- Then the new vector file (here named "gates") appears in the Layer panel. No data of gates appears on the map, of course.



## Adding data (layer) Add data of Gates

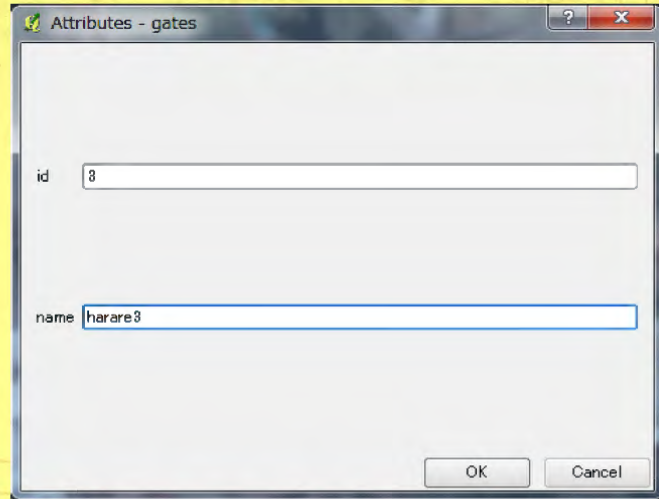
- First, set "gates" layer in the edit mode.
- To do that, point "gates", right click and select "Toggle Editing".
- Then click Add feature icon, and point the location of a gate on the orthophoto.





## Adding data (layer) Add data of Gates (2)

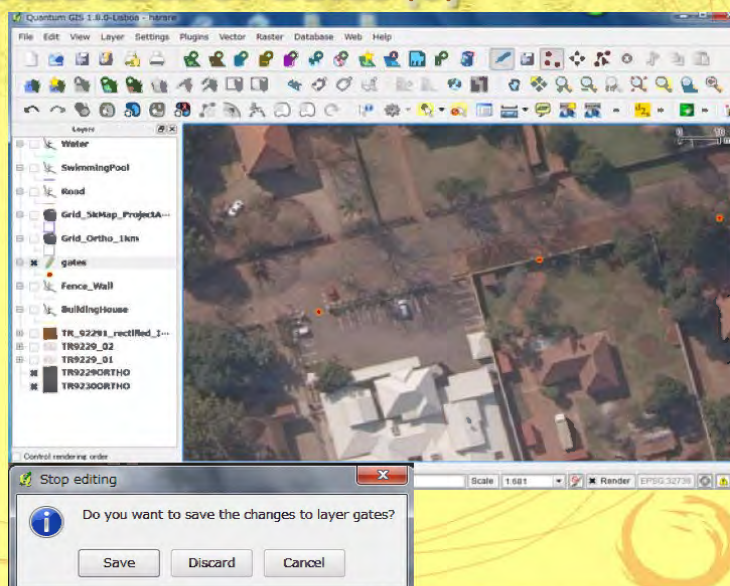
- A new window appears and ask you to input "id" and other attributes (here only attribute "name")



The screenshot shows a dialog box titled "Attributes - gates". It contains two text input fields. The first field is labeled "id" and contains the number "3". The second field is labeled "name" and contains the text "harare3". At the bottom right of the dialog, there are two buttons: "OK" and "Cancel".

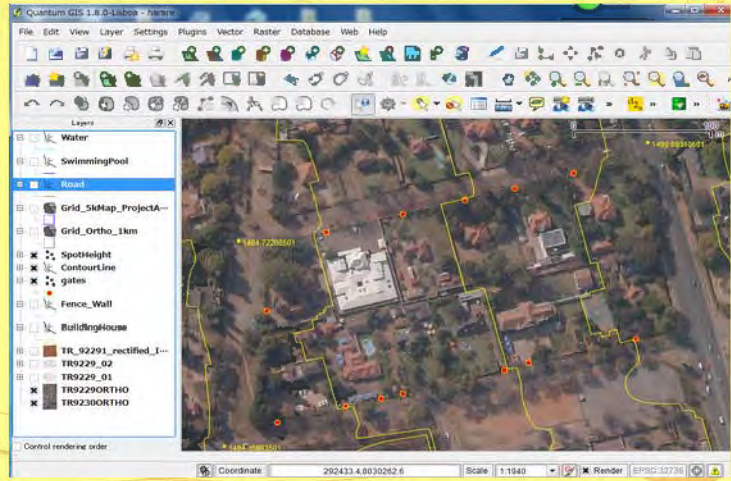
## Adding data (layer) Add data of Gates (3)

- Press "OK" after setting attribute values, then gates data are shown on the prthophoto.
- After inputting all the gates in the target area, point "gate", right click and "Toggle Editing" in order to stop editing. Then press "save" for the "Stop editing" message.



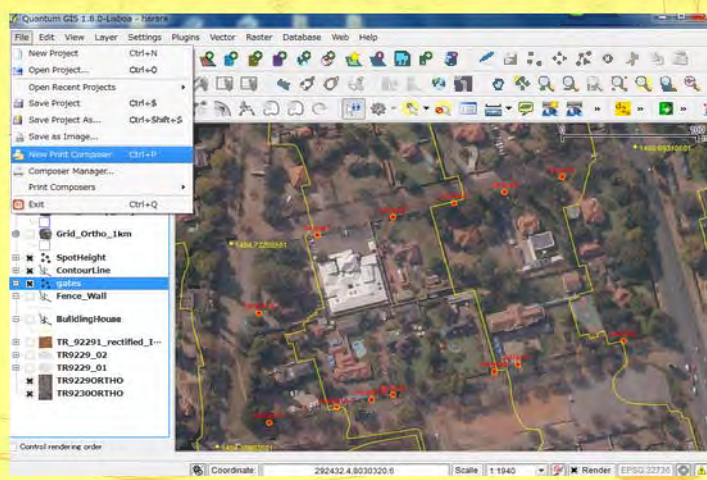
## Adding data (layer) Add data of Gates (4)

- After saving, gates are shown as orange dots on the orthophoto
- Here, contour (yellow lines), and spot heights (yellow dots) are added.
- Of course, do not forget to save the project from time to time.



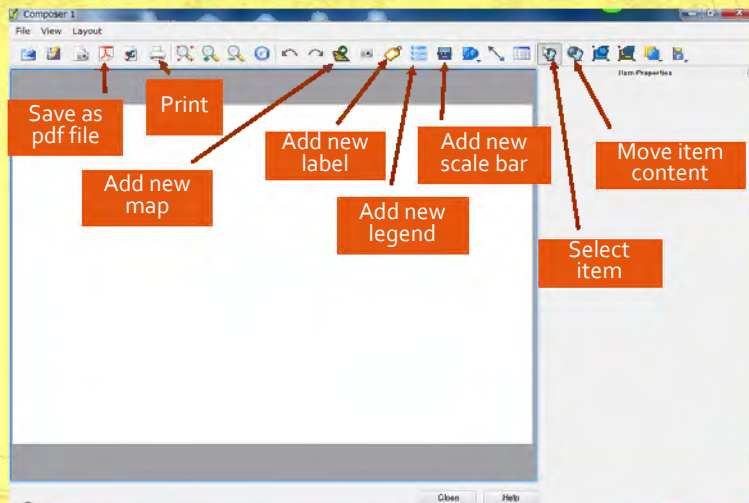
## Making map and output

- The previous work of adding gates can be fixed as a kind of map product using QGIS.
- First, click "File" and choose "New Print Composer".



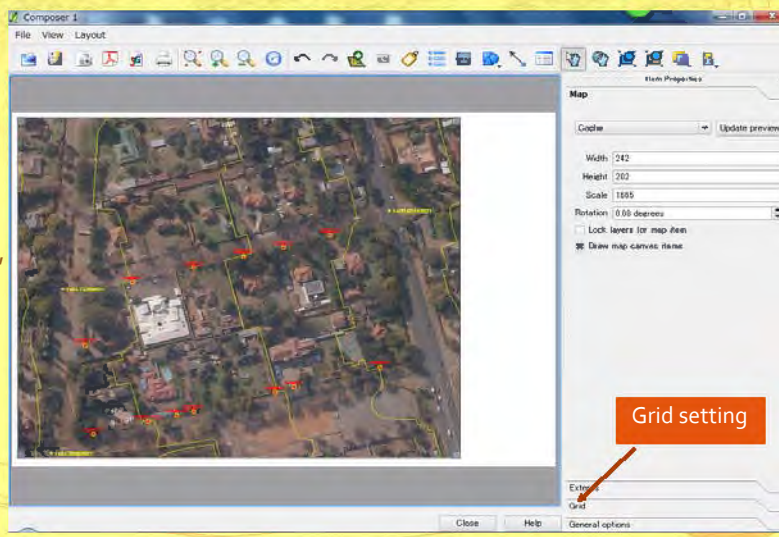
## Making map and output

- Then, layout window appears.
- Icons shown in the top of the window have various function such as adding a map, label, legend, scale bar.
- Once those items are put on the composer, select item to change the parameters of selected item.



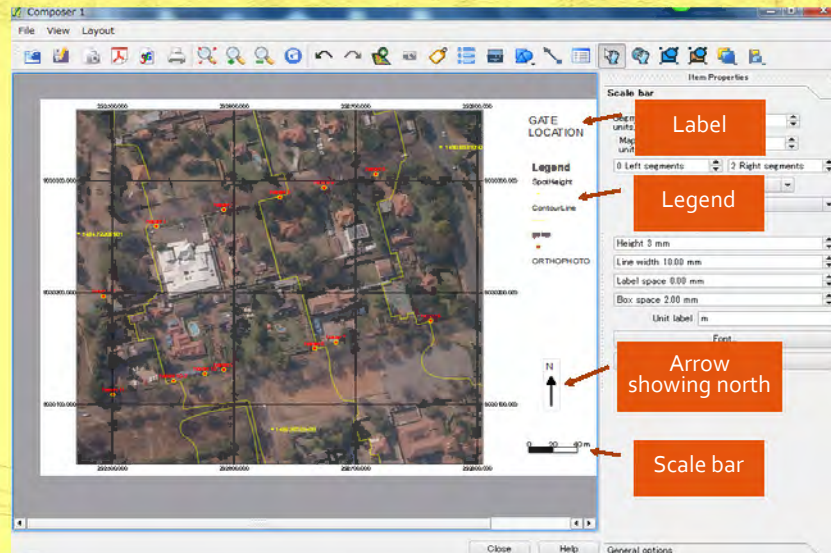
## Making map and output (2)

- "Add new map" is selected and deployed on the sheet in the composer. The content in the main window is shown in the beginning.
- In the right side, several parameters can be set as you like



## Making map and output (3)

- Final product.
- You can directly print the result or save it as a pdf file.



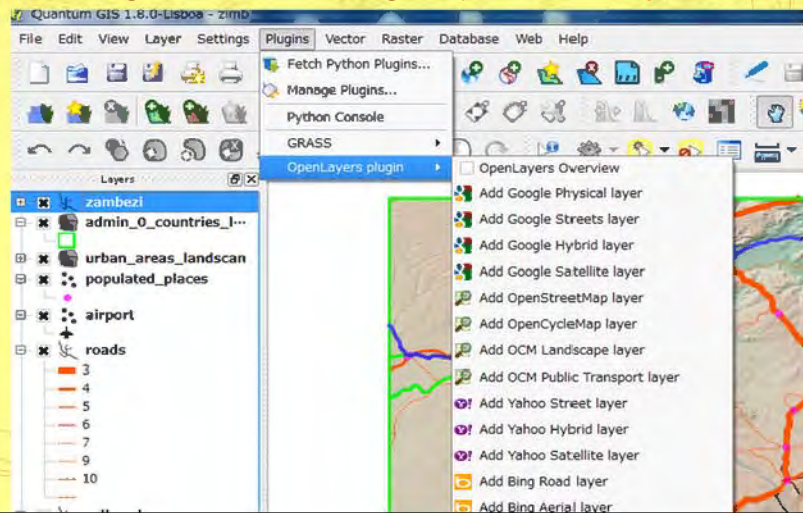
Thank you for your kind attention

- If you have any questions or comment, please contact to the following address

Hiromichi Maruyama  
Infrastructure Development Institute-Japan (IDI)  
idio5@idi.or.jp

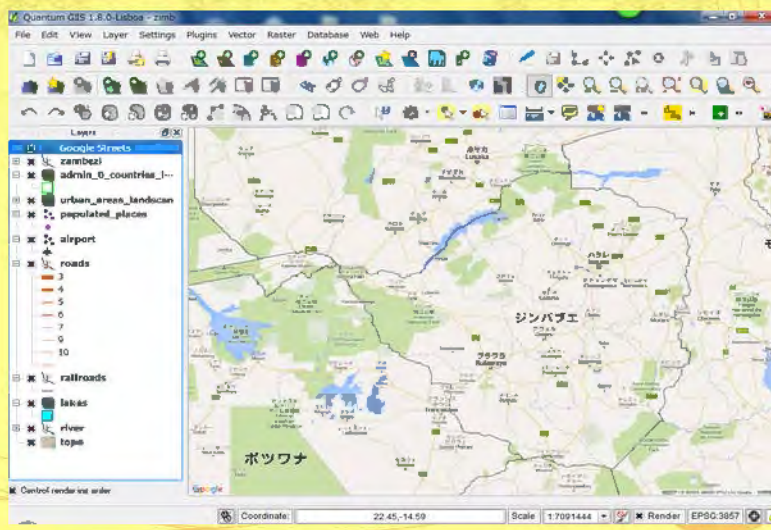
## Appendix: Integration with Google Map

- QGIS enables us to add global data such as Google Map. **Internet is required**
- Start from Zimbabwe project file. First, click "Plugins", select "Open Layers plugin", then various existing map data are shown as menu.
- Here, select "Add Google Streets layer".



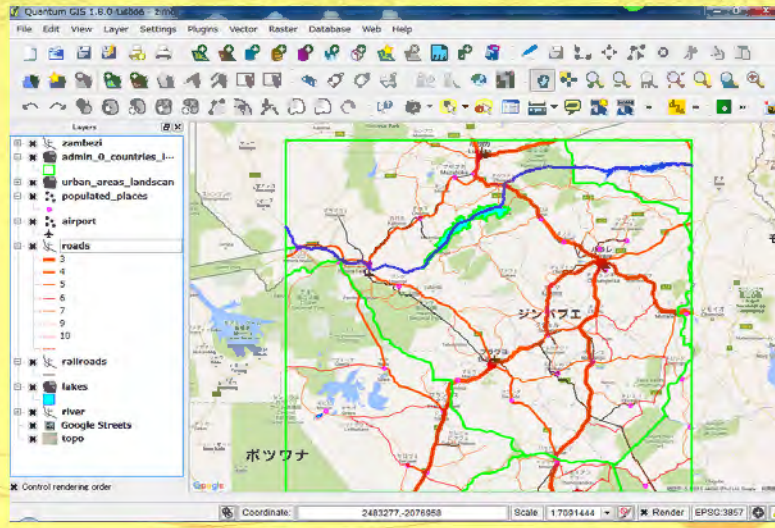
## Appendix: Integration with Google Map (2)

- Then Google Map is shown.



## Appendix: Integration with Google Map (3)

- To show other layers, we move Google Streets layer to the bottom but topography layer. The result is shown in the right image.



## **9. The presentation materials and local reports of the Final seminar**

- 9.1. “Project Results” by JICA Study Team
- 9.2. “How the project products support local authority administration” by DSG and JICA Study Team
- 9.3. “Utilization of the Project Products” by Chitungwiza City
- 9.4. “Distribution of the Project Products and Plan for Future Mapping Projects in Zimbabwe” by DSG
- 9.5. The local newspaper article reporting the project completion





**THE DEVELOPMENT OF  
A GEOSPATIAL INFORMATION DATABASE PROJECT IN THE  
REPUBLIC OF ZIMBABWE**

# **Project Results**

**Yoshiteru MATSUSHITA (Project Leader)**

**Team Leader of the JICA study team  
for the Greater Harare Mapping Project**

**Final Seminar  
29 March, 2017**

**Rainbow Towers, Harare**



## **PRESENTATION OUTLINE**

### **1. Introduction of the project**

### **2. Project Results**

- Map and Geospatial datasets
- Capacity development of the DSG
- Utilization of the maps and geospatial datasets



## **INTRODUCTION OF THE PROJECT**

### **In the Greater Harare,**

- In order to plan and maintenance of infrastructure, large-scale base maps are required
- However, the existing large-scale topographic maps, which were produced more than 30 years ago are out-of-date.
- The GoZ requested the GoJ for a technical cooperation programme to;
  - produce the 1:5,000 scale digital base maps and ortho-photo imagery and;
  - implement capacity development so that DSG can produce digital base map and GIS database.

## **PROJECT AIMS AND OBJECTIVES**

### **I. Develop the Geospatial Information Database based on WGS84 datum for the Greater Harare**

Specific objectives:

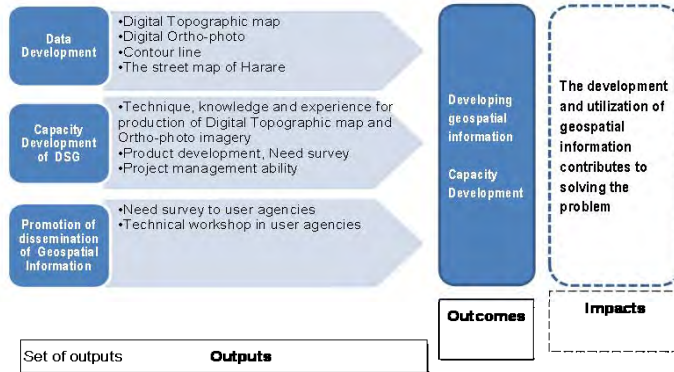
- i. Acquire digital aerial photographs for the project area which to be used for producing 1:5,000 digital topographic map and digital ortho-photo;
- ii. Produce 1:5,000 large-scale digital topographic maps for Center of the City of Harare;
- iii. Produce ortho-photo imagery map with contour line covers for Harare, Chitungwiza, Epworth, Ruwa and Manyame River system.

### **II. Capacity Development for DSG**

Specific objectives:

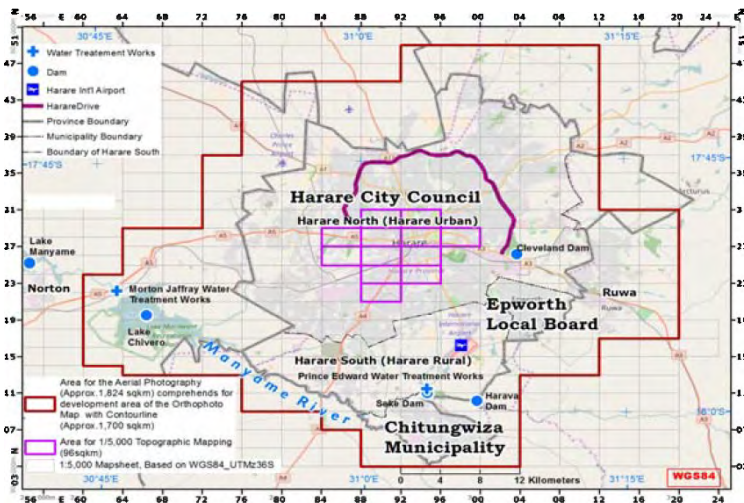
- i. Conduct training programmes in order to develop capacity to produce digital topographic maps and ortho-photo imagery. DSG is expected to provide geospatial dataset which helps to solve various issues in the region covered by the geospatial dataset.

# PROJECT OUTPUT AND OUTCOME



5

# PROJECT TARGET AREA

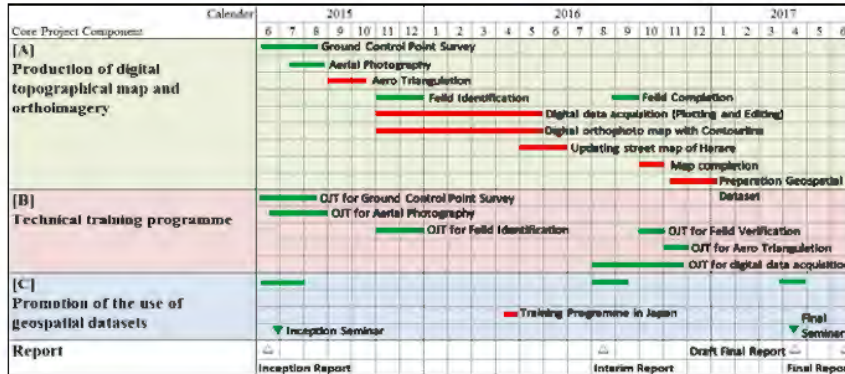


- (1) 1:5,000 scale digital topographic maps: 96 km<sup>2</sup>
- (2) Digital orthophoto map with contours: Approx. 1,700 km<sup>2</sup>
- (3) Digital aerial photo and aerial triangulation: Approx. 1,824 km<sup>2</sup>

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## PROJECT SCHEDULE



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## CORE PROJECT RESULTS

### I. Production of digital topographic maps and ortho-photo imagery map with contour line, those maps fit together with GPS positioning.

- i Digital topographic map for the center of Harare has been updated
- ii Digital ortho-photo image and ortho-photo image map with 2 meter interval contour line that covers the Greater Harare and Manyame river was prepared
- iii The street map of Harare based on WGS84 datum was updated

### II. Capacity development for DSG

- i Capability for digital topographic mapping of DSG was introduced
- ii One digital photogrammetric work station and several mapping equipments was introduced at DSG
- iii As training programme in Japan, four DSG counterparts visited to various institutions in Japan to learn examples of development and use of geospatial data in Japan.

### III. Promotion of the use of geospatial information database

- i Outreach programme to promote the use of geospatial datasets has been done with DSG

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## CORE PROJECT RESULTS I

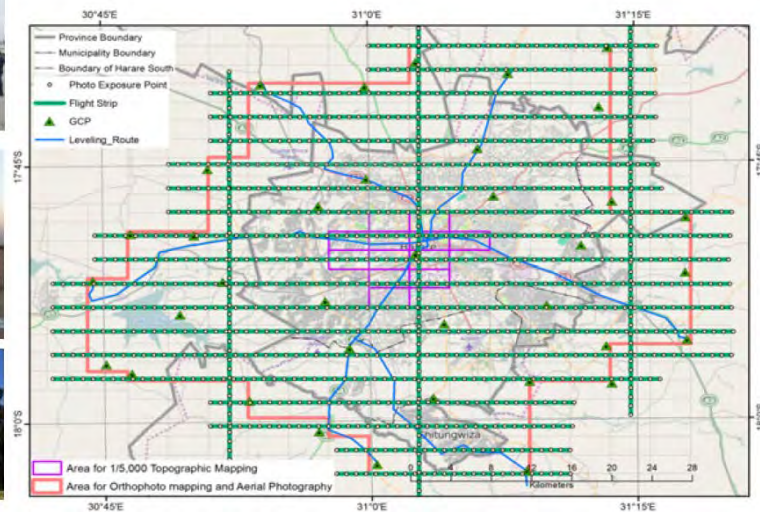
I. Production of digital topographic maps and ortho-photo imagery map with contour line, those maps fit together with GPS positioning.

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- iii The street map of Harare based on WGS84 datum was updated

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## AERIAL PHOTOGRAPHY ON 19<sup>TH</sup> JULY 2015



10

AERIAL PHOTOGRAPHY  
WITH 20CM RESOLUTION  
ON GROUND DISTANCE



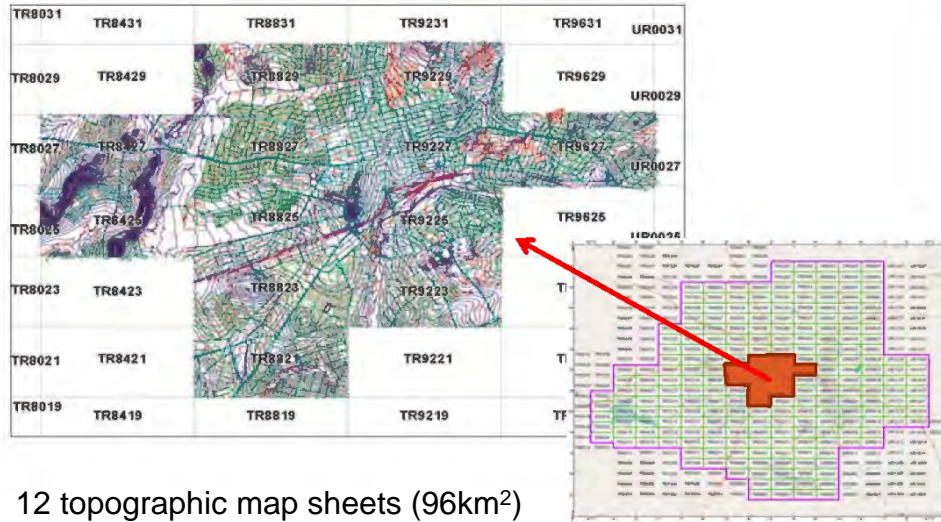
11

AERIAL PHOTOGRAPHY  
WITH 20CM RESOLUTION  
ON GROUND DISTANCE



12

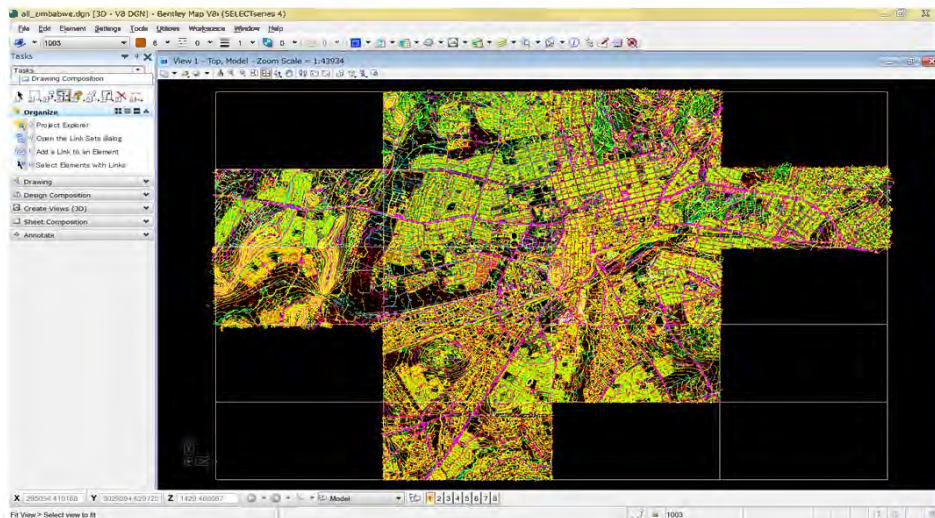
## DIGITAL TOPOGRAPHIC MAP FOR THE CENTER OF HARARE



12 topographic map sheets (96km<sup>2</sup>)  
1 map sheet: 4km X 2km

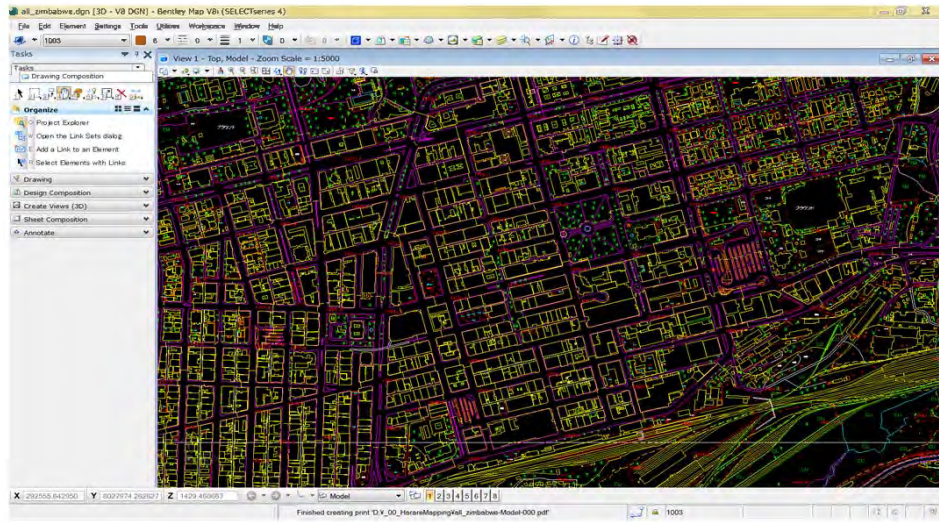
13

## 1:5,000 DIGITAL TOPOGRAPHIC MAP



14

# 1:5,000 DIGITAL TOPOGRAPHIC MAP



# DIGITAL TOPOGRAPHIC MAP FOR THE CENTER OF HARARE





## DIGITAL ORTHO-PHOTO IMAGE AND ORTHO-PHOTO IMAGE MAP WITH 4 METER INTERVAL CONTOUR LINE



17

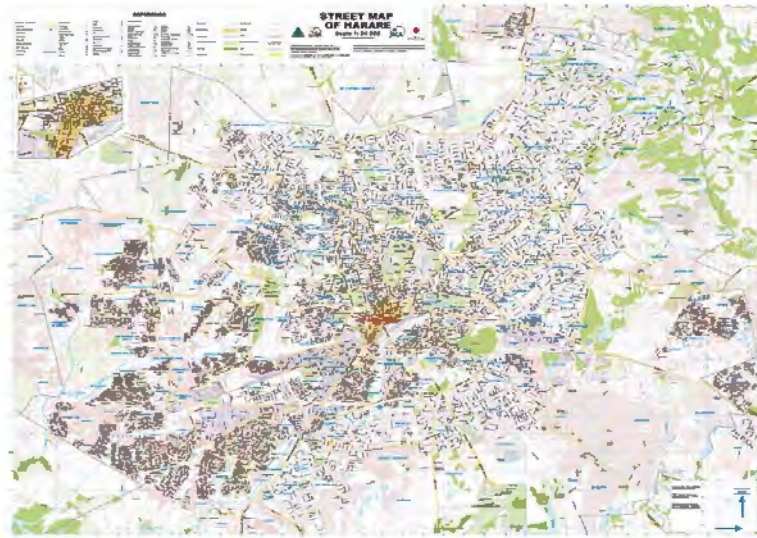
## DIGITAL ORTHO-PHOTO IMAGE AND ORTHO-PHOTO IMAGE MAP WITH 4 METER INTERVAL CONTOUR LINE



18



## NEW THE STREET MAP OF HARARE



21

## NEW THE STREET MAP OF HARARE



Partially enlarged 200%

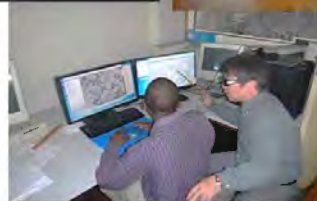
22

## CORE PROJECT RESULTS

### II. Capacity development for DSG

- i Capability for digital topographic mapping of DSG was introduced
- ii One digital photogrammetric work station and several mapping equipments was introduced at DSG
- iii As training programme in Japan, four DSG counterparts visited to various institutions in Japan to learn examples of development and use of geospatial data in Japan.

## CAPACITY DEVELOPMENT OF DSG AND PROCESS OF TOPOGRAPHIC MAPPING WITH PHOTOGRAMMETRY



## GROUND CONTROL POINT LAYOUT



25

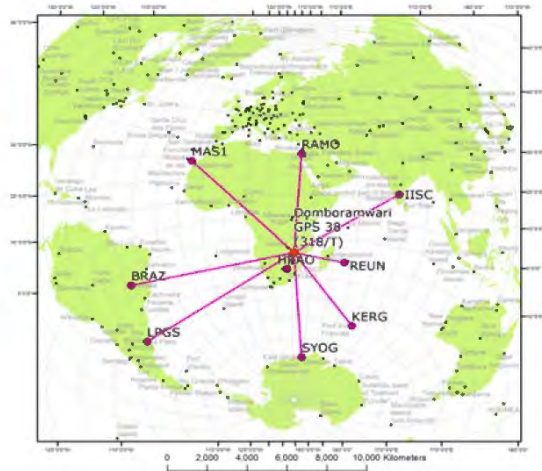
## GROUND CONTROL POINT LAYOUT

- GPS observation for the 36 GCPs
- Performs the leveling observation for the route, length with 264.5km. The leveling had attached orthometric height to the 19 GCP points



26

# ESTABLISHMENT OF REFERENCE POINT ON WGS84 DATUM



27

# AIR MARKING



28

# GROUND CONTROL POINT SURVEY



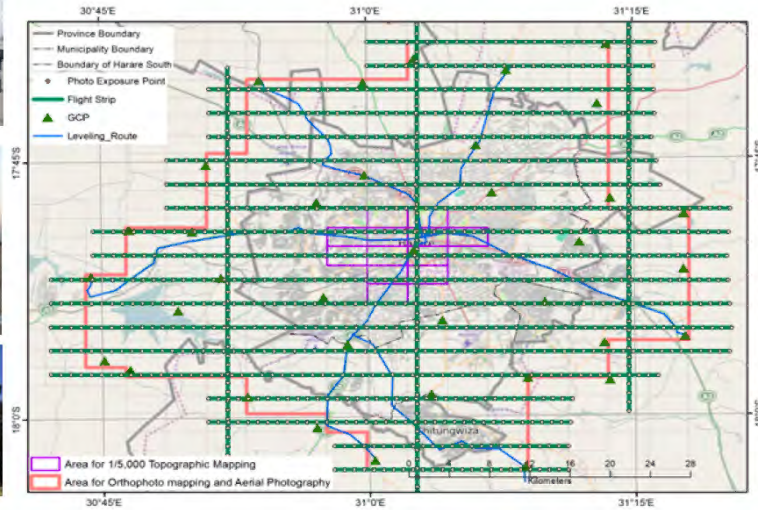
29

# GROUND CONTROL POINT SURVEY



30

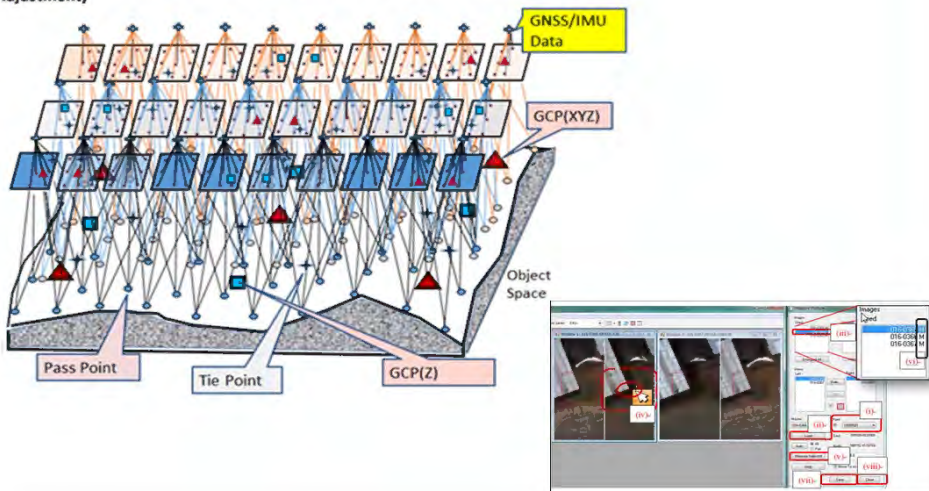
# AERIAL PHOTOGRAPHY



31

# AERIAL TRIANGULATION

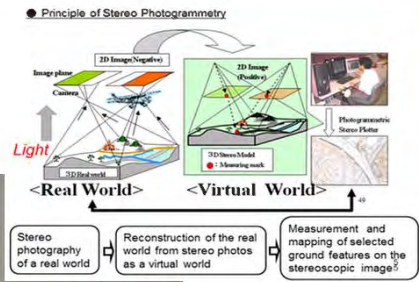
(3D Triangulation Network for Aerial Triangulation to be Established by Bundle Adjustment)



32



# DATA CAPTURE WITH FULL DIGITAL PHOTOGRAMMETRY



33

# FIELD IDENTIFICATION AND VERIFICATION



34

## FIELD IDENTIFICATION AND VERIFICATION COLLECTING ANNOTATION DATA



35

## TRAINING IN JAPAN, GEOSPATIAL INFORMATION AUTHORITY OF JAPAN (GSI)



36

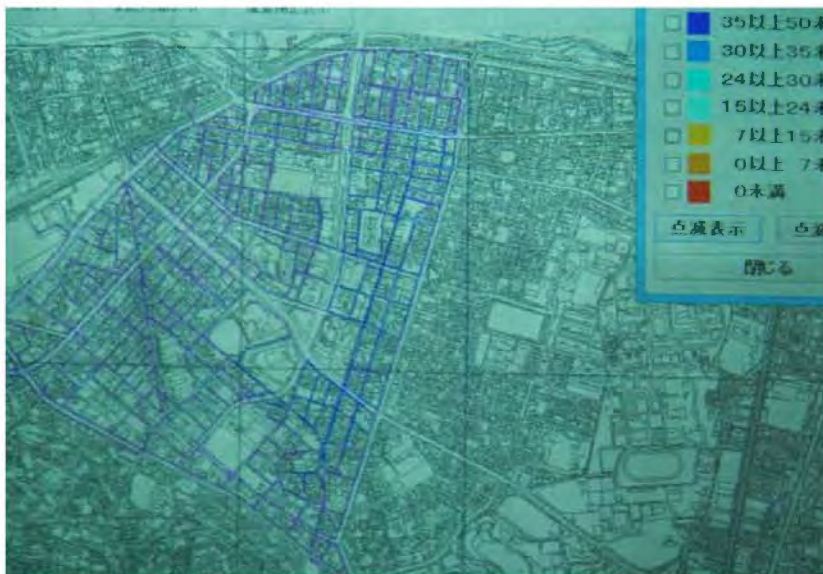
## TRAINING IN JAPAN, USECASE OF BASE MAP IN WATER WORKS

Kitakyuushuu city water and  
sewage bureau



37

## ONE EXAMPLE OF USECASE OF BASE MAP IN WATER WORKS



38

## CORE PROJECT RESULTS

### III. Promotion of the use of geospatial information database

- i Outreach programme to promote the use of geospatial datasets has been done with DSG

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## OUTREACH PROGRAMME TO PROMOTE THE USE OF GEOSPATIAL DATASETS



Discussion on new product development with DSG



Technical workshop at Chitungwiza City Office, Lecture on how to use ortho-photo image and GIS

40

*Tatenda/ Siyabonga kakulu*

*ありがとう (Arigatou)*



DEVELOPMENT OF A GEOSPATIAL  
DATABASE IN THE REPUBLIC OF  
ZIMBABWE



**Project Products: Supporting Local Authorities**  
- POTENTIAL USES OF LARGE SCALE URBAN GEOSPATIAL DATABASE -

**Presented by Canaan F. Ndambakuwa**  
**Chief Land Surveyor-GIS**  
Department of the Surveyor General  
Final Seminar – 29 March 2017  
Rainbow Towers – Harare  
[cndambakuwa@yahoo.com](mailto:cndambakuwa@yahoo.com)



## Presentation Outline



- Introduction
- Challenges
- Geospatial Products
- Aim of the Presentation
- Some Uses of the Project's Products
  - Urban Planning for new developments
  - Management of Water and Sanitation Hygiene infrastructure
  - Urban Transport
  - Post and Courier Services
  - Telecoms and Power utilities
  - Civil Protection
  - Crime Prevention
  - Tourism

2



## Introduction

- Geospatial information has been widely recognized as an important aspect of sustainable socio-economic development. As such, the availability of quality geospatial data and information from authoritative sources ensure decision makers and other concerned stakeholders of an accurate common operational picture of critical scenarios before, during and after occurrence.

3



## Challenges and Opportunities

- The population of the City of Harare has rapidly increased due to a number of driving forces (658000 in 1982 to about 1.6 million in 2012)
- **Challenges :**
  - ✓ Poor urban services, traffic congestion, growth of informal settlements, etc.
  - ✓ Environmental degradation and disasters
  - ✓ Lack of accurate and well-structured GIS datasets for urban planning and infrastructure development
- **Opportunities:**
  - The project geospatial products provide high-resolution datasets useful for:
    - ✓ (1) infrastructure, and
    - ✓ (2) sustainable socioeconomic development

4





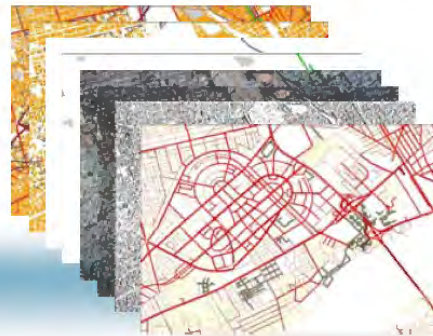
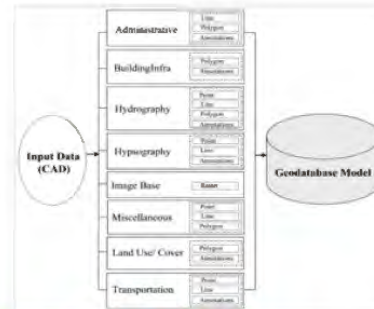
## Geospatial Products

The geospatial model comprises:

- ❖ Seven feature datasets
- ❖ A raster dataset
- ❖ More than 100 feature classes

 HarareTestGDB\_Model1.gdb

- +  Administrative
- +  BuildingInfrastructure
- +  Hydrography
- +  Hypsography
- +  LandUseCover
- +  MiscellaneousStructures
- +  Transport
-  ImageBase



## Aim of the Presentation

- To highlight some of the uses that the project's developed geospatial database can be put to.





## Urban Planning for developments

- Planning for new developments
- Regularizing Unplanned Settlements



## Regularization of Unplanned Settlement



8



## Management of Water and Sanitation (Kitakyushu e.g.)



9



## Other Services

### ➤ Urban Transport

- Traffic Flow (One Way / Two Way)
- Traffic Control (Traffic Lights, Police Control)

### ➤ Health Services

- Health Facilities, Public Ablution, Refuse Disposal

### ➤ Post and Courier Services

- Delivery of mail, parcels, newspapers etc.

### ➤ Telecoms and Power utilities

- Underground and overhead Cabling + associates infrastructure

10



## Other Services

- Civil Protection
  - Evacuation routes, Location of Hydrant Valves
- Crime Prevention
  - Policing Areas, Black Spots

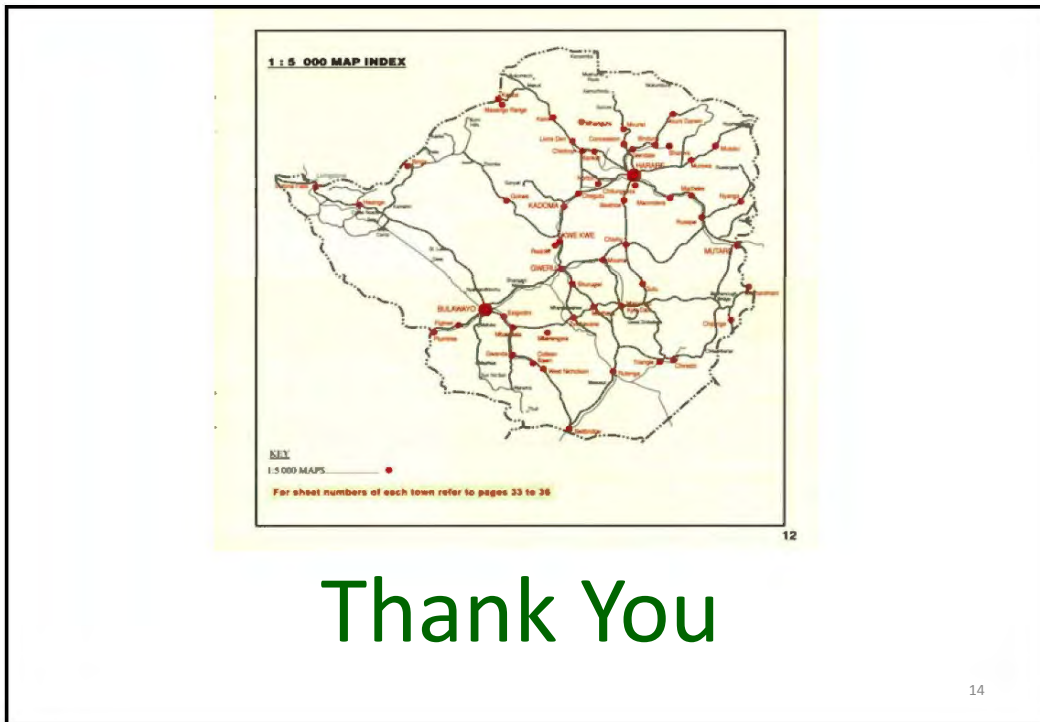
11







## Miscellaneous Uses



12



Thank You

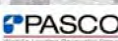



**THE DEVELOPMENT OF  
A GEOSPATIAL INFORMATION DATABASE PROJECT IN THE  
REPUBLIC OF ZIMBABWE**

**PROJECT PRODUCTS: SUPPORTING  
LOCAL AUTHORITIES**

**Courage Kamusoko  
Asia Air Survey Co., Ltd**

**Final Seminar  
29 March, 2017  
Rainbow Towers, Harare**












## **PRESENTATION OUTLINE**

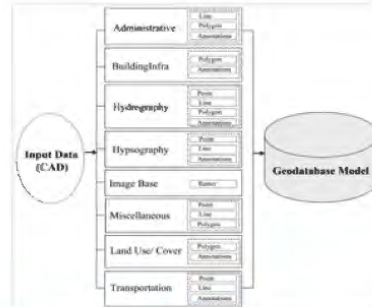
- Geospatial Products & Applications
- Geospatial Online Portal
- Summary

## GEOSPATIAL PRODUCTS

The geospatial model comprises:

- ❖ seven feature datasets
- ❖ a raster dataset
- ❖ More than 100 feature classes

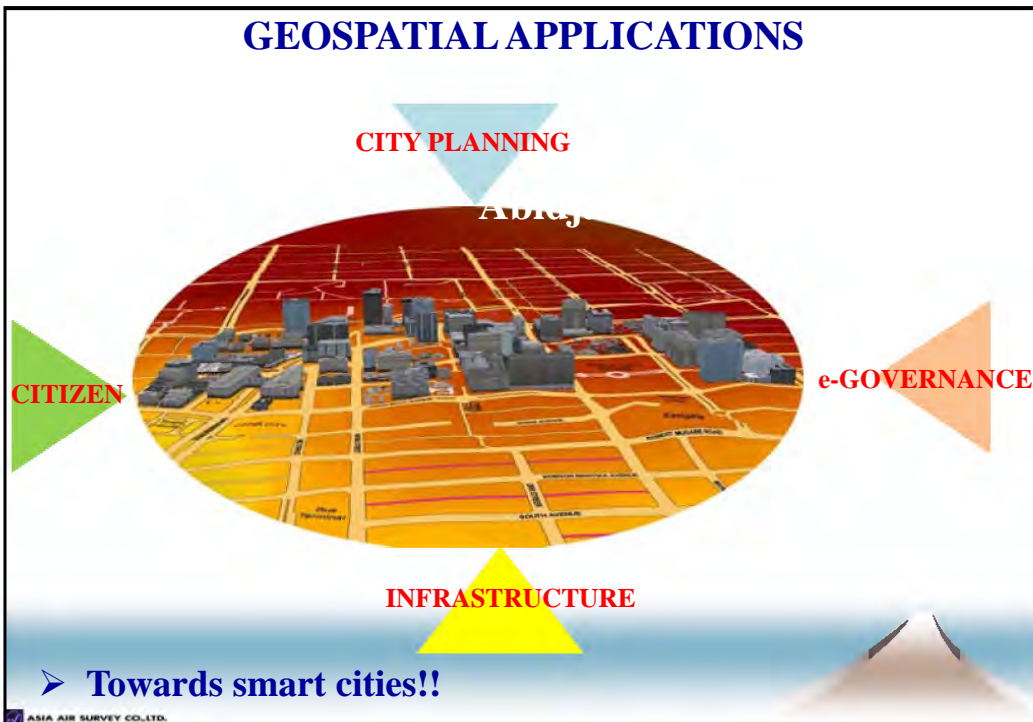
 HarareTestGDB\_Model1.gdb  
 Administrative  
 BuildingInfrastructure  
 Hydrography  
 Hypsography  
 LandUseCover  
 MiscellaneousStructures  
 Transport  
 ImageBase



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## GEOSPATIAL APPLICATIONS



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## GEOSPATIAL APPLICATIONS



- Perform proximity analysis: distance between built-up areas & stream
- Does the built-up and stream distance confirm to city by-laws?
- Can be used for wetland zoning

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## GEOSPATIAL APPLICATIONS



- Cell tower locations
  - Wireless facilities (towers, rooftops, etc) to deploy or fill-in cellular and other wireless coverage
- Space utilization - 3D maps can be used to:
  - create virtual walk in cities;
  - plan developments, check visibility etc.

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## DSG GEOSPATIAL ONLINE PORTAL

<https://dsg-zim1.maps.arcgis.com/home/index.html>

**The Department of the Surveyor-General**

The Department of the Surveyor-General (DSG) invites you to explore this geospatial platform. Use this platform to view maps that are produced at various scales and other geospatial information products as well as updates on completed and on-going projects.

[Home](#)
[ArcGIS Marketplace](#)
[Help](#)
[Terms of Use](#)
[Privacy](#)
[Contact Us](#)
[Report Abuse](#)

- To promote the project's geospatial products
- To enable government and stakeholders to access GIS data

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## SUMMARY

- A geospatial information database was developed to manage the project geospatial datasets
- The project geospatial datasets comprise seven feature datasets, a raster dataset and more than 100 feature classes
- An online geospatial portal was developed to promote the project geospatial products
- The geospatial information database and the online geospatial portal is expected to provide a base for developing NSDI.

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Tatenda/ Siyabonga kakulu!

ありがとうございました!

Thank you very much!



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THE DEVELOPMENT OF  
A GEOSPATIAL INFORMATION DATABASE PROJECT IN THE  
REPUBLIC OF ZIMBABWE

## UTILISATION OF THE PROJECT PRODUCTS

### CHITUNGWIZA MUNICIPALITY



**Final Seminar**  
**29 March, 2017**  
**Rainbow Towers, Harare**

## ABOUT CHITUNGWIZA

- ▶ Chitungwiza is the largest high density town in Zimbabwe. The city is approximately 30 kilometres south of the capital city, Harare. It was formed in 1978 from three townships: Seke, Zengeza, and St Marys. Around early 2000 another township named Manyame Park (New St Marys) was established making them four.



## ABOUT CHITUNGWIZA

- ▶ It covers an area of 42 square kilometres and a population of 365 026 according to 2012 population census.
- ▶ Chitungwiza is a dormitory town of Harare, but due to its expansion and growth its gaining a city status.
- ▶ Services are provided by Chitungwiza Municipality [\[1\]](#) which is run by the Chitungwiza Municipality Ward Councilors. There are 25 wards in Chitungwiza, and from the 25 ward councillors, a mayor, deputy mayor and finance committee chairperson are selected from these councillors. The councillors including those elected for posts serve for 5-year term of office and are overall elected by the ward residents on Zimbabwe harmonized elections. The one who is in charge of the management and all employees of Chitungwiza Municipality, is the Town Clerk.

## PRESENT MAPPING SITUATION IN CHITUNGWIZA

- ▶ **Currently Chitungwiza is using cadastral and street maps prepared in the year 2000.**
- ▶ The geographical information we have is out dated.
- ▶ We have a poor filing system .

### Problems we are facing

- ▶ We can not access our cadastral maps easily.
- ▶ We can not certainly identify where planning activities have taken place hence making it difficult for future planning.

### As a result

- ▶ We need an updated map for future proper planning

## EXPERIENCE OF USING DIGITAL ORTHOPHOTO

WORKSHOP ORGANISED BY JICA  
AND CHITUNGWIZA MUNICIPALITY

- ▶ The workshop had 23 participants from various sections of the council
- ▶ QGIS (open source GIS software) were trained using orthophoto covering area of 1 km x 2 km in the municipality in the workshop.

One scene of the workshop



Participants of the workshop



## EXPERIENCE OF USING DIGITAL ORTHOPHOTO

WORKSHOP ORGANISED BY JICA AND CHITUNGWIZA MUNICIPALITY



In the workshop, it was recognized manholes can be easily identified on the orthophoto .

➔ This means the orthophoto has a great possibility to map various facilities which Chitungwiza Municipality deals with.

## EXPERIENCE OF USING ORTHOPHOTO AFTER THE WORKSHOP



This photo shows sewer manholes indicated in yellow stars  
The manholes are on the sewer trunk line along Tilco drive

## EXPERIENCE OF USING ORTHOPHOTO AFTER THE WORKSHOP



This photo shows speed humps indicated in orange dots  
The humps are located in various road segments.

## EXPERIENCE OF USING ORTHOPHOTO AFTER THE WORKSHOP



This photo shows tower lights in red dots  
The tower lights are in various locations of Zengeza suburb.

## EXPERIENCE OF USING ORTHOPHOTO AFTER THE WORKSHOP



This photo shows culverts in red lines  
The culverts are located in Zengeza 3 urban local roads and in Tilcor drive.

## EXPERIENCE OF USING ORTHOPHOTO AFTER THE WORKSHOP



This photo shows residential properties in an orange boundary. These properties were developed on a wet land thus exposing them to a high risk of floods

## EXPERIENCE OF USING ORTHOPHOTO AFTER THE WORKSHOP



This photo shows a stream indicated by a blue line. If we receive high rainfall, the properties nearby are subject to being flooded.

## EXPERIENCE OF USING ORTHOPHOTO AFTER THE WORKSHOP

### From our experience using orthophoto and QGIS

- ▶ QGIS its easy to use
- ▶ The software is stable to use on any computer or operating system hence making it user friendly.
- ▶ Its cheaper compared to other softwares.
- ▶ We can easily identify our manholes, developable areas ,wet lands ,open spaces infrastructural development on the orthphotos

## FUTURE PLAN TO USE DIGITAL ORTHOPHOTO AND ORTHOPHOTO IN CHITUNGWIZA

### Engineering purposes:

- ▶ Water- creation of a map to navigate water valves and speed hydrants
- ▶ Roads- navigating positions which requires culverts with use of contour lines
- ▶ Sewer- navigation of manholes for monitoring of functional & non functional
- ▶ Electricity -position of tower lights for easy identification during mantainence
- ▶ Fire brigade -water sources, easier routes to use to get to a certain position i.e. they need to avoid roads with many speed humps



## FUTURE PLAN TO USE DIGITAL ORTHOPHOTO AND ORTHOPHOTO IN CHITUNGWIZA

### Health Purposes

Its used to determine the following:

- › location of boreholes i.e. functional and non-functional
- › location of schools for sanitary inspections purpose
- › location of dump sites for clearance purposes
- › water sampling sentinel points for water quality monitoring
- › public convenience places for hygienic audits

### Planning Purposes

- › For development of new layouts
- › Cadastral purposes
- › Identification of wet lands
- › Identification of condemned areas

## FUTURE PLAN TO USE DIGITAL ORTHOPHOTO AND ORTHOPHOTO IN CHITUNGWIZA

### CHALLENGES

- › We don't have the modern hardware e.g. computers, printers etc.
- › We don't have adequate training
- › People need to be motivated to migrate from old systems to new systems

# CONCLUSION

- ▶ Digital orthophoto has huge potential to make various works in the administration of municipality of Chitungwiza easier.
- ▶ Digital mapping using orthophoto is the powerful way to use especially in this third world we are living in.
- ▶ We kindly appeal to donors who wish to assist us with the necessary resources



# Distribution of Project Products

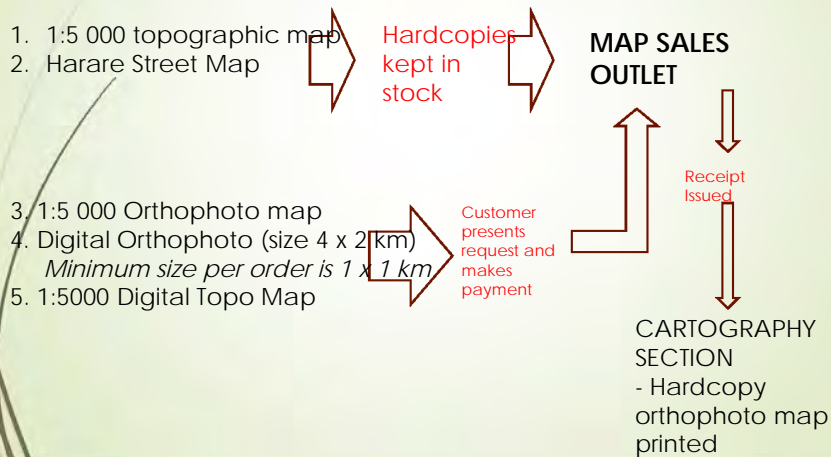


## THE PRODUCTS

- ▶ **Digital Orthophotos**
- ▶ **1:5 000 Digital Topographic Map**
- ▶ **1:5 000 Topographic Map (Line Map)**
- ▶ **1:5 000 Orthophoto map (with contour lines and place names)**
- ▶ **Revised Harare Street Map at 1:34 000 scale**
- ▶ Digital Elevation Model (10m grid elevation data – ASCII Grid)
- ▶ Digital Elevation Model (Stereo Matching) 10m grid elevation data
- ▶ Digital Cadastral Orthophoto map
- ▶ Digital cadastral topographic map
- ▶ Street guides for the project area

## ACCESS TO PRODUCTS BY THE PUBLIC

- Five products are going to be immediately available by July 2017



## Future Mapping Plans

- Latest Harare 1:5000 topo maps were produced in 1985 from aerial photography acquired in that same year
- Revision is coming after exactly 30 years!
- Latest in series is the Bindura 1:5000 topo map produced in 1997 from aerial photography acquired in 1996
- Problems associated with developments based on outdated maps cannot be over-emphasised
- Need to adhere to revision cycles critical (desired 5 years)

**THEREFORE!.....**

.....

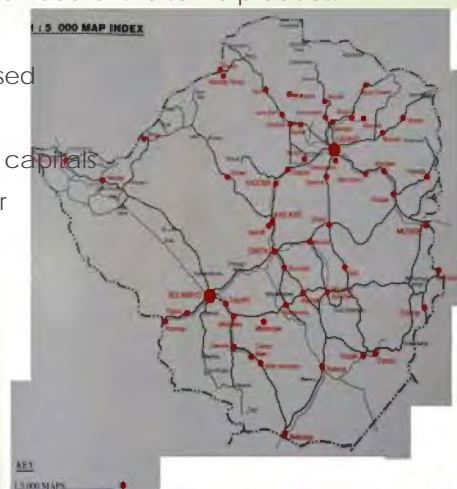
.....it is critical that the remaining 1604 sq.km be finished by 2019 at the latest!

#### REQUIREMENTS

- 10 more Digital Photogrammetry Workstations need to be procured for use by staff currently in post
- All products produced in Japan, training done locally
- Need to reduce the gap between training and actual production
- Increase the number to 21 after the filling-in of vacant posts
- Pleasing to note Government commitment as highlighted by Honourable Minister
- Already USD15 000 has been set aside for the procurement of hardware for an additional DPW

## BEYOND HARARE

- This type of mapping is not limited to Harare alone
- Other urban centres have in dire need of the same products
- Map highlights areas to be revised
- Total area **6 380 sq.km**
- Next phase to target provincial capitals and smaller towns in that order





Harare city

## Govt completes first phase of Harare digital map

Tinashe Makichi  
Property Reporter

**G**OVERNMENT in partnership with the Japanese International Co-operation Agency (JICA), has completed the first phase of the Harare digital map.

The Harare map was last revised 30 years ago through Japan's technical cooperation; "the project for the Development of a Geospatial Information Database in the Republic of Zimbabwe".

Under the project JICA was to make a detailed and accurate digital map of Harare and its environs and to transfer mapping technology to the Department of the Surveyor General of Zimbabwe.

"We hope that in the near future, the maps elaborated under this project will be utilized for the development planning of infrastructure such as water and electricity supply, and will become an effective tool for improved administrative services," said Japan Chargé D'Affaires to Zimbabwe Dabide Tsunakake.

Mr Tsunakake said the map includes not only detailed and accurate "ortho-photo" plain data of Greater Harare,

but also three dimensional topographic data. He said Japan's ultimate goal is for the project to contribute to the realisation of the existing Zimbabwean national economic blueprint, Zimbabwe Agenda for Sustainable Socio-Economic Transformation.

"It is my sincere hope that this new Harare Map will be available to residents of Harare, including myself, who are in need of an accurate street atlas," said Mr Tsunakake.

Mr Tsunakake said the product has potential to significantly change the efficiency of the development works in the future.

"Of course I know that such construction works on the ground are not at all the main mission of the Department of Surveyor General.

"But those who have made the digital Harare Map with such useful topographic data are from now on responsible for disseminating this project product among other relevant local authorities in charge of those ground works and for enlightening stakeholders on how to utilise it for future development."

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