# NEW ROADS FOR RESILIENCE

## Reconnaissance report from Uganda

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Roads for Water

GLOBAL RESILIENCE PARTNERSHIP

"New Roads for Resilience: Connecting Roads, Water and Livelihoods"

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| | |
|---|---|
| B | Busia District |
| FAO | Food and Agriculture Organisation |
| GEP | Google Earth Pro |
| GPS | Global Positioning System |
| IFAD | International Fund for Agriculture Development |
| JICA | Japan International Cooperation Agency |
| M | Mbale District |
| MMR | MetaMeta Research |
| MoWT | Ministry of Works and Transport |
| PCS | Projected Coordinate System |
| QGIS | Quantum Geographical Information System |
| T | Tororo District |
| ToR | Terms of Reference |
| UBOS | Uganda Bureau of Statistics |
| UNMA | Uganda National Meteorological Authority |
| UNRA | Uganda National Roads Authority |
| WGS 84 | World Geodetic System 1984 |

# 1 Introduction and objectives

As part of the project "New Roads for Resilience: Connecting roads, water and livelihoods" funded by the Global Resilience partnership, the Roads for Water consortium aims to transform roads in Sub-Saharan African, including Uganda, into instruments for water harvesting to contribute towards improved water supply, better soil moisture, reduced erosion along roads and respite from harmful damage. This study aims at developing a first case to be used for the development of the initiative in Uganda.

The goal of this study is to explore the possibilities for the development of the road water harvesting initiative to improve livelihoods in Uganda. The specific objectives of this study are:

1. Identify pilot roads to be analysed in the districts of Busia, Tororo and Mbale
2. Carry out a quick, georeferenced inventory of roads characteristics and problematics related to water, water drainage
3. Carry out a situation analysis of the road sector in the region and in the country

## 1.1 Project Background

Roads have a major impact on the landscapes immediately surrounding them – determining the movement of water, sediment, dust and others. Roads have an important impact on rain run-off. De facto roads often act either as an embankment or as a drain/conveyance systems and thus bring major changes to the natural hydrology. These modifications now often have negative impacts: roads cause local floods and water logging along the way, whereas the more concentrated discharge from drains and culverts cause erosion and sedimentation. These negative impacts are related to the prevailing practice in road engineering to evacuate water away from the roads as soon as possible rather than making use of the water for beneficial purposes. All this undermines the resilience of roadside communities, who lose crops or property or suffer health effects from road dust.

This negative however can be turned into a positive and roads can be systematically used as instruments for water harvesting. It can generate substantial positive impacts: more secure water supply, better soil moisture, reduced erosion and respite from harmful damage. It leads to better returns to land and labour and a higher ability of people, households and communities to deal with and thrive in the face of shocks and stresses.

With the investment in roads in many countries exceeding that of any other programme (in Ethiopia it is for instance 30% of the national budget), this is a large opportunity to improve the productive environment and increase the resilience of the population near the road.

Currently the project is mainly active in Ethiopia and Kenya, but in consequent phases the aim is to upscale in other African countries including Uganda. This study aims at developing a first case to be used for the development of the initiative in Uganda.

# 2 Identifying pilot roads

## 2.1 General

Primary and secondary roads in Busia, Tororo and Mbale districts were mapped using Google Earth Pro and imported into the QGIS software to re-project the data, generate a required attribute table and merge the district specific roads shapefiles to make one shape file for all roads mapped. 29 roads were mapped with a total length of 389.45 km as determined from Google Earth Pro and QGIS measurement tools with the shortest road mapped having 1.25 km and longest went up to 45km. Out of these roads only nine roads and the road to Nakapiripirit were considered for the data inventory collection. According to the ToRs, the total length of the roads was not to exceed 50 km but since getting to the selected sections of the roads a given distance along the same road was travelled, certain features were identified and included with in the data making the starting points to change in some cases. Therefore, in the presentation of the results the total length of the roads considered is way above 50 km.

## 2.2 Methodology

The results for this specific objective of the project have been obtained through the following procedures:

### 2.2.1 Preparing district polygon shapefiles

The project area consisted of three political district which included Mbale, Busia and Tororo districts located in Eastern Uganda bordering western Kenya. To keep within the geographical scope of assignment, the contractor delineated the project area using QGIS software from the Uganda districts administrative data obtained from UBOS. These clipped files have been used as a guidance during the vector analysis performed within the QGIS environment.

### 2.2.2 Mapping the required roads

Both primary and secondary roads required have been mapped using Google Earth Pro software using the "add path" tool in the menu bar. After mapping them, they have been saved in a kml format which later were imported into the QGIS environmental to carryout vector analysis.

### 2.2.3 Re-projection of data to a uniform PCS

The imported data from Google Earth Pro has been converted from the kml format to enable generation of the required attribute information. By a similar process, all shapefiles generated were re-projected in a new PCS called WGS 84. This has been done to prepare a platform for the action of the merge tool.

### 2.2.4 Generation of the attribute data

The required data agreed upon between the interns (contractor) and the project manager of MMR in the data collection sheets part 1, has been generated using the Google Earth Pro, open street map and UNRA data and attached to the shapefiles through addition of new columns in the attribute table as shown in figure 3.2. The attribute data generated to fit the required roads inventory were SN, GEP_NAME, UNRA_NAME, ROAD_CLASS, ROAD_TYPE, LENGTH, DIF_HEIGHT, SOIL_TYPE, LU_CROSSED and GPS_CODE.

1) Serial number. The serial number indicated for each road is carrying letter(s) and numerals. The letter(s) indicates the district within which the specific road is found and for roads crossing district boundaries, the first letter represents the district of origin and the last letter represents district the road is running to. The numeral

indicated on the serial number represents the road number within the district where it is found.

2) GEP_NAME. This column represents the name of the mapped roads as found from the google earth pro software. This has been generated in comparison with google earth pro representation.
3) UNRA_NAME. This column represents the name of the road depending on the UNRA naming. This has been generated through comparison of roads data with the data obtained from UBOS that was submitted to them from the UNRA GIS department.
4) ROAD_CLASS. The road class specifically indicates whether the road is a primary or a secondary road. This has been generated using sight inspection and open street map attribute data and guided by classification according to UNRA.
5) ROAD_TYPE. The road type shows the type of the material covering the road. They are mostly bituminous or unsealed roads. This column has been generated through sight inspection, contractor's knowledge of the study area and data from UNRA.
6) LENGTH. This column represents the length of the road in particular. It has been generated using the distance measurement tool of QGIS software. It has also been used in determining total length of the whole project roads.
7) DIF_HEIGHT. This column represents a difference in altitude form the starting point of the road to the final point of the road.

The soil type and land use crossed columns were left blank in the attributes table but instead the description at certain points were notes in the data inventory under description refer to ANNEX 1.

### 2.2.5 Merging individual shapefiles

The various roads mapped from the individual districts have been merged together using the merge tool in QGIS software.

### 2.2.6 Selecting pilot roads

These were selected to over 50 Km length in total, a 25 m contour map of the study area from QGIS and the Elevation profile tool from GEP were used to determine the roads and sections of roads in some cases for the data inventory collection stage. The table below shows the codes (SN) of the selected roads and the start coordinates (start 36 N, E) and

the end coordinates (end 36 N, E) along each road. The Nakapiripirit road was later added into the study since it was being given special attention by the station UNRA office in Mbale due to the too much water flowing across it.

*Table 2-1 Showing the selected road length along the pilot roads*

| SN | Start 36 N | E | End 36 N | E | Max Slope | Length |
|---|---|---|---|---|---|---|
| M005 | 0626964 | 0126270 | 0630753 | 0121462 | 0.80 | 6.124 |
| M012 | 0638152 | 0122804 | 0632274 | 0119901 | 15.50 | 6.560 |
| M014 | 0636804 | 0116745 | 0634698 | 0118267 | 35.00 | 2.60 |
| M015 | 0637068 | 0111760 | 0635725 | 0112991 | 15.90 | 1.825 |
| TB01 | 0629799 | 0072954 | 0616100 | 0063795 | 0.30 | 16.502 |
| TM04 | 0630253 | 0106435 | 0630909 | 0085851 | 53.50 | **20.629** |
| TB03 | 0625926 | 0062506 | 0630409 | 0072932 | 0.70 | 11.382 |
| B002 | 0610409 | 0033800 | 0611493 | 0038291 | 0.70 | 4.612 |
| M008 | 0623062 | 0118960 | 0625455 | 0118832 | 1.30 | 2.395 |
| NAK | 0678994 | 0192653 | 0667949 | 0172741 | | 22.87 |
| | | | | | **Total Length** | **95.499** |

## 2.3 Results

Using the methodology described before, the following results were obtained: a total of 29 roads in Busia, Tororo and Mbale districts were mapped covering a length of **389.45 km**.

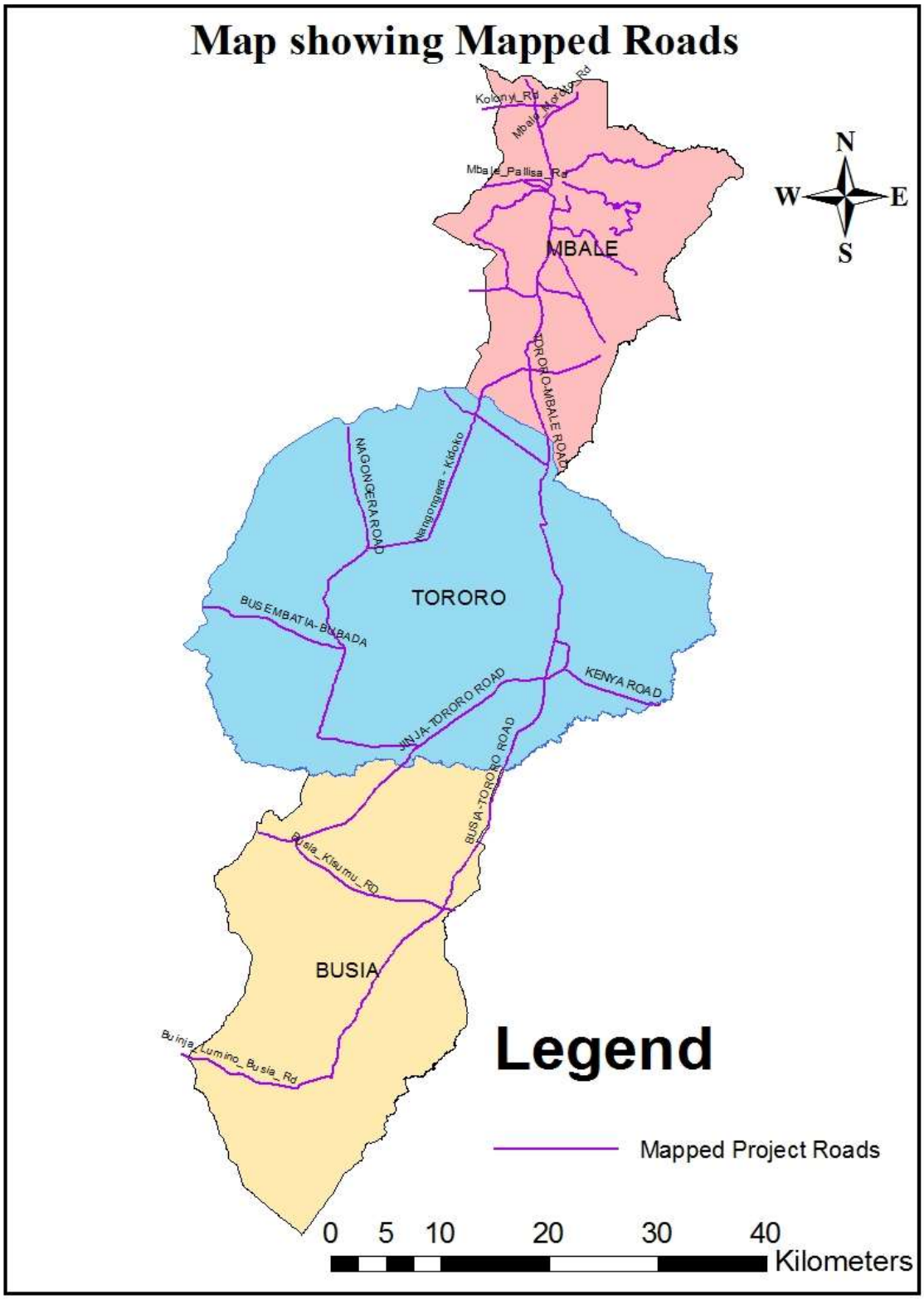



*Figure 2- Mapped Roads*

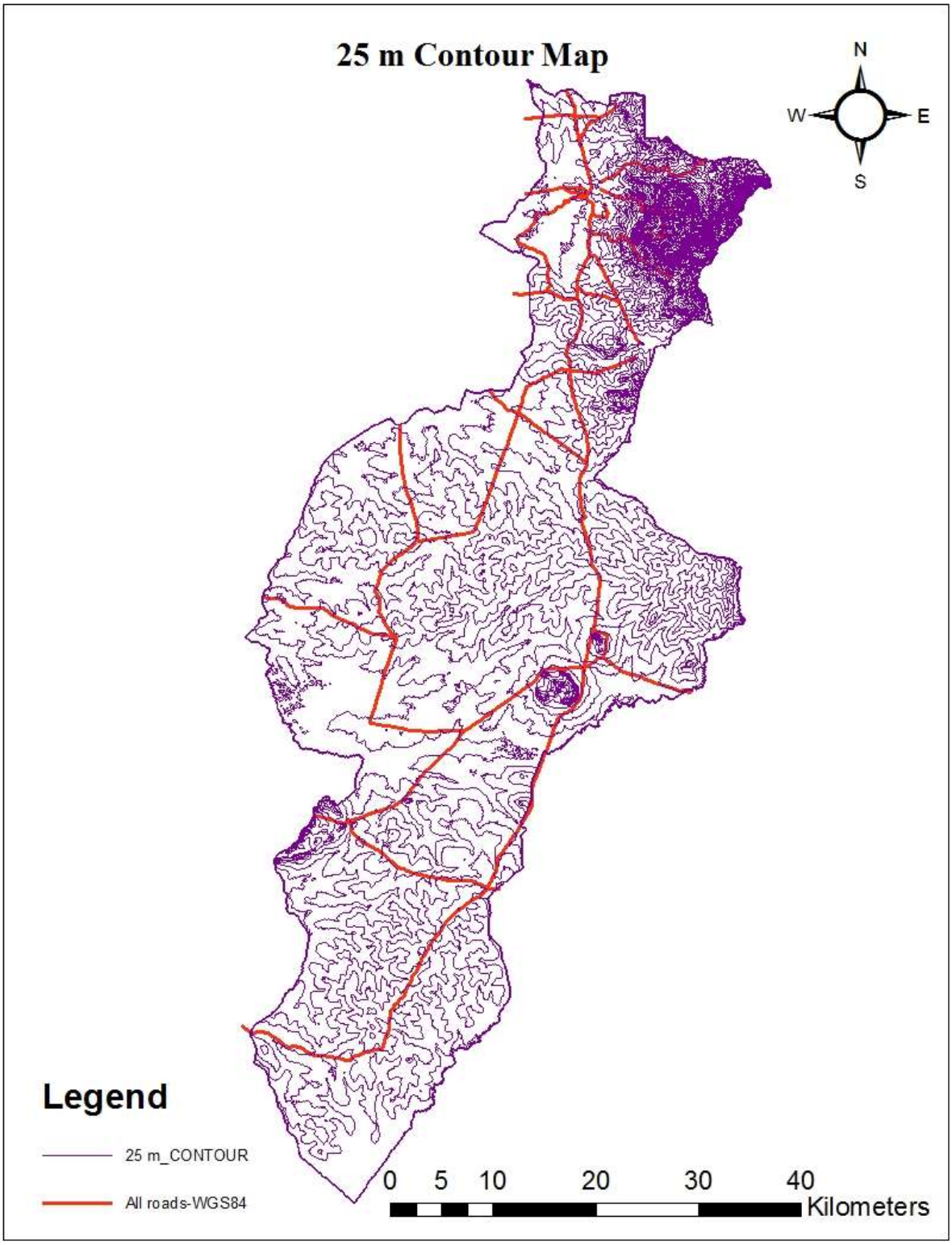



*Figure 2-2 A 25 m contour map used for the selection of pilot roads*

# 3 Developing a georeferenced inventory of pilot roads

## 3.1 General

The selected pilot roads were given the priority in data collection, however at some point the road to Nakapiripirit District through Kween District was included following advice from the Station engineer in Mbale as this road has a lot of water flowing from the hill which has become a problem to this particular road.

## 3.2 Methodology

For each of the selected roads, we used a GPS, a Camera and a vehicle to move along as we noted the coordinates at a point of interest and taking descriptive notes by either interviewing local people or by observation and taking pictures at that point. A point on or along a road was noted if it had one or more of the following: Faults (damages to the roads), Borrow pits, Main drainage structures (e.g. drains and culverts), Water erosion signs, Road-induced flooding, Road-induced water logging or sedimentation, Existing water harvesting, water recharge practices along roads, Challenges and Opportunities for road water harvesting, Available rainfall data (Weather station nearby and or Meteorological authorities) and Other interesting features

## 3.3 Findings from field visits

The pilot project region can be divided into two areas considering the main economic activities which could give a clear picture of the water harvesting systems to be established and for a given purpose. The areas in Nakapiripirti lie in the Karamoja region also called the *cattle corridor* whilst the districts of Mbale, Tororo and Busia lie in a totally crop farming area. In the agricultural-based districts mainly maize, millet, sorghum, beans, cassava, banana, sweet potatoes, vegetables and rice are the crops grown. Further findings from the field as the georeferenced inventory of the pilot roads was being generated, are discussed below.

### 3.3.1 The existing situation of roads in the project area

The situation of the roads registered in the project area belonged to three major categories:

- With established drainage

Regarding the summarised data in the annex.1 appendix of this report, 10% of the pilot roads had established drainage systems. This may have been caused by the fact that some roads were unsealed roads and therefore the responsible body hadn't realised the benefits of establishing an improved drainage system in the region. This makes such roads unfavourable for water harvesting systems that may require established drains in area to collect enough amount of water for improving livelihoods.

- Poor and locally dug drains

About 40% of the pilot roads had poor drains or locally dug drains. The poor drainage was associated with grassy drains, incapacitated culverts, drains filled up with solid wastes and locally dug drains which are subjected to erosional effects. All the above associated causes of poor drainage have made the road sector a source of water logging that develop into breeding places for mosquitoes thus affecting the locals during rainy seasons. In the same manner, they lead to increased flooding in the region breaking off some parts of the region from the rear during rainy seasons.

- No existing drains

The remaining portion of the piloted roads completely had no drainage system in place. This makes such areas subject to the costs of drainage systems as new water harvesting systems are to be established.

### 3.3.2 Effects of water on the roads

a) Pot holes in the road and flooding

The existing drainage system is insufficient for accommodating the large amount of water collected by the road catchments in the project area. Thus, the development of pot holes and iterative flooding of the roads has sharply increased. This has decreased the longevity of the road structures and transport safety on roads since safety remains dependent on the season of the year. This also affects the economics of the maintenance sector, the planning sector, the livelihood of the locals living along these communication lines.

Furthermore, with the current designs of UNRA, the sole purpose of the drainage system established along roads is to eliminate water away from the roads before the former affects the latter. Without a specific water storage reservoir for water from roads, the developers are left with the only option of leaving the water run to the adjacent land. This increases the risk of flooding of the agricultural gardens during heavy rains and affects the plantations.

b) Erosion

Erosion problems were also recorded along most of the roads, some were rillies while others were gullies as shown in the figure below. Due to erosion, many road structures like bridges have been damaged, drains have been silted, culverts have been carried away and this has become a big threat to road safety.

*Figure 3-1 Gully formed due erosion along Tororo-Jinja Road in Busere village in Tororo District. (Threat of road collapsing)*

c) Sedimentation /siltation

Various sedimentation/siltation problems were recorded from the field work. Mostly they were downstream of culverts. Sedimentation/siltation is caused by the debris carried by the running water along the roads. This blocks the culverts that are designed to convey the water from one side of the road to another to avoid flooding.


*Figure 3-2 Siltation at Okurut Bridge located on the Road to Nakapiripirit District*

**Existing water harvesting systems**

The existing water harvesting systems occur mostly accidentally. For example, the series of pictures below show a small pond naturally formed due to collection of water from a road catchment and this water is used for irrigation in the dry season. Also in some areas where earth for road construction was excavated (borrow pits) the depressions left behind are now collecting water from which cattle drink. Very few people have embraced water harvesting and many see the too much water as a threat to their crops.


*Figure 3-3a, b and c: Naturally occurring water harvesting system*

# 4 Results from field findings

The summarised findings are shown in table below. Each road is represented by the Road s/n (e.g. B002, M015 ….), for each item(s) recorded along the road such as; Faults, damages

to the roads (water related), Borrow pits, Main drainage structures (e.g. drains and culverts), Water erosion sign, Road-induced flooding, Road-induced water logging, Road-induced sedimentation and Existing water harvesting, water recharge practices along roads, the location co-ordinates where taken using a GPS, also noting the description and challenges/opportunities at that point.

*Table 4-1 Summary of findings from the field data collection*

| S/N | CODE | START (N, E) | END (N, E) | LENGTH km | NO. OF EXISTING WHS | WATER TO ROADS EFFECTS FOUND |
|---|---|---|---|---|---|---|
| 1 | B002 | 0610409, 0033800 | 0611493, 0038291 | 4.612 | 4 | • Poor drainage and incapacitated culverts (3)<br>• Sedimentation and erosion signs (4)<br>• Road induced flooding (3)<br>• Water induced potholes and faults (1) |
| 2 | TB03 | 0625926, 0062506 | 0630409, 0072932 | 11.382 | 2 | • Sedimentation and erosion signs (1) |
| 3 | TB01 | 0629799, 0072954 | 0616100, 0063795 | 16.502 | 1 | • Poor drainage and incapacitated culverts (4)<br>• Sedimentation and erosion signs (2)<br>• Road induced flooding (3) |
| 4 | TM04 | 0630253, 0106435 | 0630909, 0085851 | 20.629 | 2 | • Poor drainage and incapacitated culverts (4)<br>• Sedimentation and erosion signs (4)<br>• Road induced flooding (4) |
| 5 | M015 | 0637068, 0111760 | 0635725, 0112991 | 1.825 | - | • Poor drainage and incapacitated culverts (4) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | • Sedimentation and erosion signs (1) |
| 6 | M012 | 0638152, 0122804 | 0632274, 0119901 | 6.560 | 2 | • Poor drainage and incapacitated culverts (5)<br>• Sedimentation and erosion signs (2)<br>• Road induced flooding (1) |
| 7 | M008 | 0623062, 0118960 | 0625455, 0118832 | 2.395 | 2 | - |
| 8 | M005 | 0626964, 0126270 | 0630753, 0121462 | 6.124 | 2 | • Water induced potholes and faults (1) |
| 9 | M014 | 0636804, 0116745 | 0634698, 0118267 | 2.600 | 1 | • Poor drainage and incapacitated culverts (3) |
| 10 | NAKAPIRIPIRIT | 0678994, 0192653 | 0667949, 0172741 | 22.869 | 1 | • Poor drainage and incapacitated culverts (2)<br>• Sedimentation and erosion signs (2)<br>• Road induced flooding (2) |

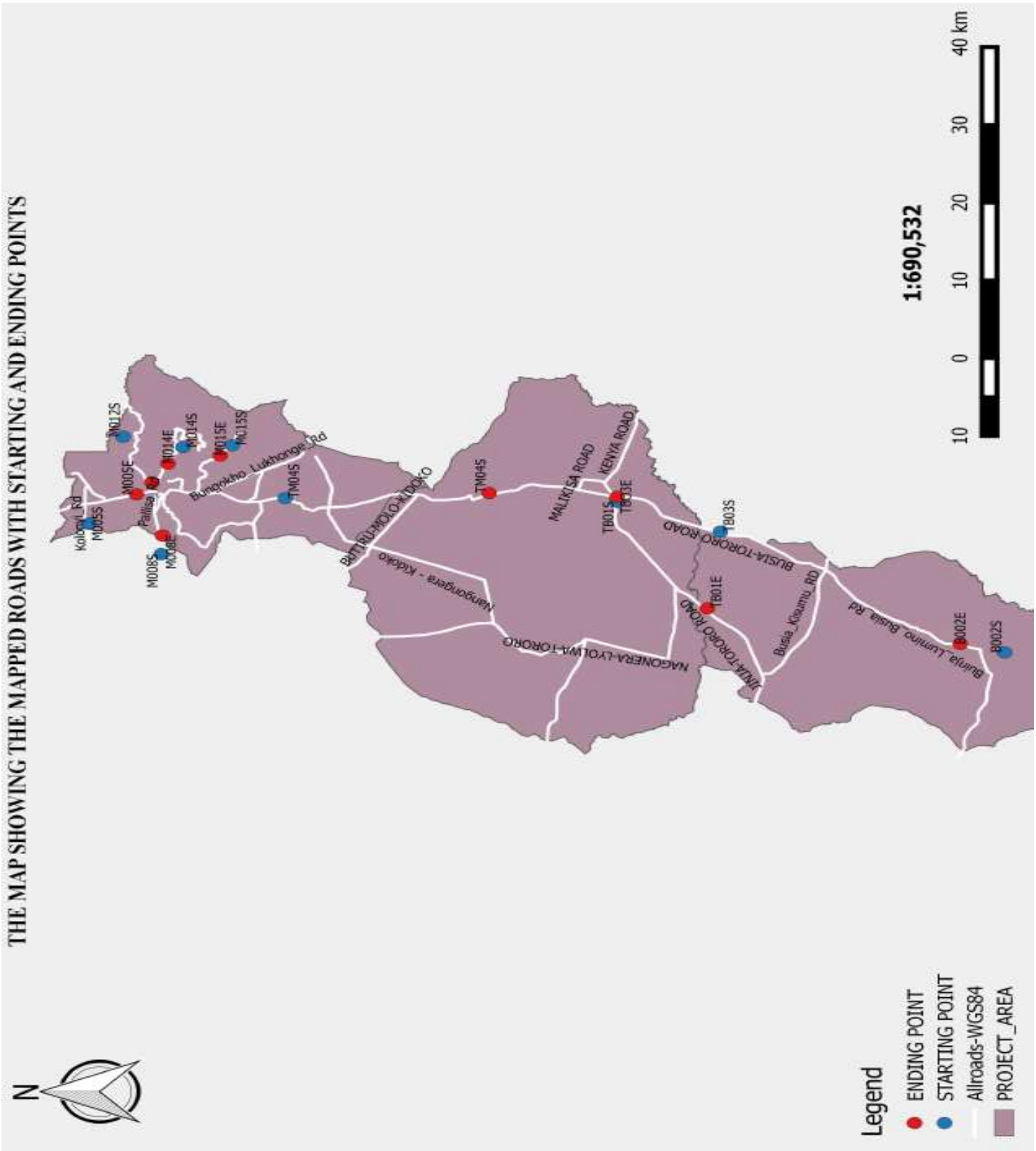



*Figure 4-1 Mapped roads with starting and ending points of analysed sections*

# 5 Situation analysis

## 5.1 General

The road sector in Uganda is managed by the Ministry of Works and transport (MoWT). This is a government institution that renders free services to the public. The Ministry gets its funding from Ministry of Finance, Planning and Economic Development in the consolidated fund. It also gets funds from donors.

MoWT exists to formulate policies, plans, set standards, build capacity carry out advocacy, regulate, monitor and evaluate the Works and Transport Sector. The Ministry also provides policy and strategic guidance to parastatal bodies under its supervision namely, Uganda National Roads Authority [UNRA], Civil Aviation Authority [CAA] and Uganda Railways Corporation [URC]. In regard to Uganda Road Fund [URF], and MoWT provides political and operational oversight in collaboration with the Ministry of Finance, Planning and Economic Development (MoWT, 2016).

The Works and Transport sector is a cluster of priority sectors of the economy comprising public building works, road, railway, water and air transport. The sector anchors the economy and serves as its conveyor belt. In consequences, its performance depends on how it relates with its clients and stakeholders in the delivery of services.

**Mandate**

The Ministry's Mandate is to:

- ✓ Plan, develop and maintain an economic, efficient and effective transport infrastructure;
- ✓ Plan, develop and maintain economic, efficient and effective transport services by road, rail, water, air and pipeline;
- ✓ Manage Public works including government structures and;
- ✓ Promote good standards in the construction industry

**Mission**

To promote adequate, safe and well maintained Works and Transport Infrastructure and Services for Social Economic Development of Uganda.

Key Functions

- ✓ Initiate, formulate and develop National Policies, Plans and Programs for safe and efficient Public Transport Infrastructure and Services.
- ✓ Monitor and Evaluate the Implementation of National Policies, Plans and Programs for safe and efficient Works, Public Transport Physical Infrastructure and Services
- ✓ Initiate new and review existing Laws and Regulations on Works and Transport Infrastructure and Services.
- ✓ Set standards for the construction industry, transport infrastructure and services.
- ✓ Enforce compliance to national policies, laws regulations and guidelines on works transport ways infrastructure and services.
- ✓ Monitoring and Evaluation of the performance of Transport Agencies.
- ✓ Inspect and license Public Transport Vehicles (PSVs).
- ✓ Provide technical support for contract works, including construction and maintenance undertaken by other Government Ministries, Departments and Agencies (MDAs).
- ✓ Initiate and formulate plans and policies for management of public buildings.
- ✓ Set and monitor national standards on public buildings.
- ✓ Carry out research and develop local materials and technology for construction Industry.

## 5.2 Uganda National Roads Authority (UNRA)

The Uganda National Roads Authority (UNRA) was established by an Act of Parliament; The Uganda National Authority Act, No. 15 of 2006. UNRA became operational on 1st July 2008.The mandate of UNRA is to develop and maintain the national roads network, advise Government on general roads policy and contribute to addressing of transport concerns, among others.

UNRA operates under an organizational structure as approved by the Board in 2008. The Authority is headed by an Executive Director (ED) appointed by the Minister of Works and Transport (UNRA, 2016).

In the UNRA organizational structure, there are five Directorates, each headed by a Director who reports to the Executive Director.

The Directorates are:

- ✓ Planning,
- ✓ Projects,
- ✓ Operations,
- ✓ Finance and Administration,
- ✓ Internal Audit.

Within each Directorate there are Managers, Project Engineers/Officers, and Technicians and support Staff in order or hierarchy. The Legal Counsel and Corporate Communication Officer report directly to the Executive Director.

# 6 Recommendations

## 6.1 Recommendations

This section includes some of the ideas on how to start up activities in Uganda and some of the partners to include in the workshop in which findings should be presented.

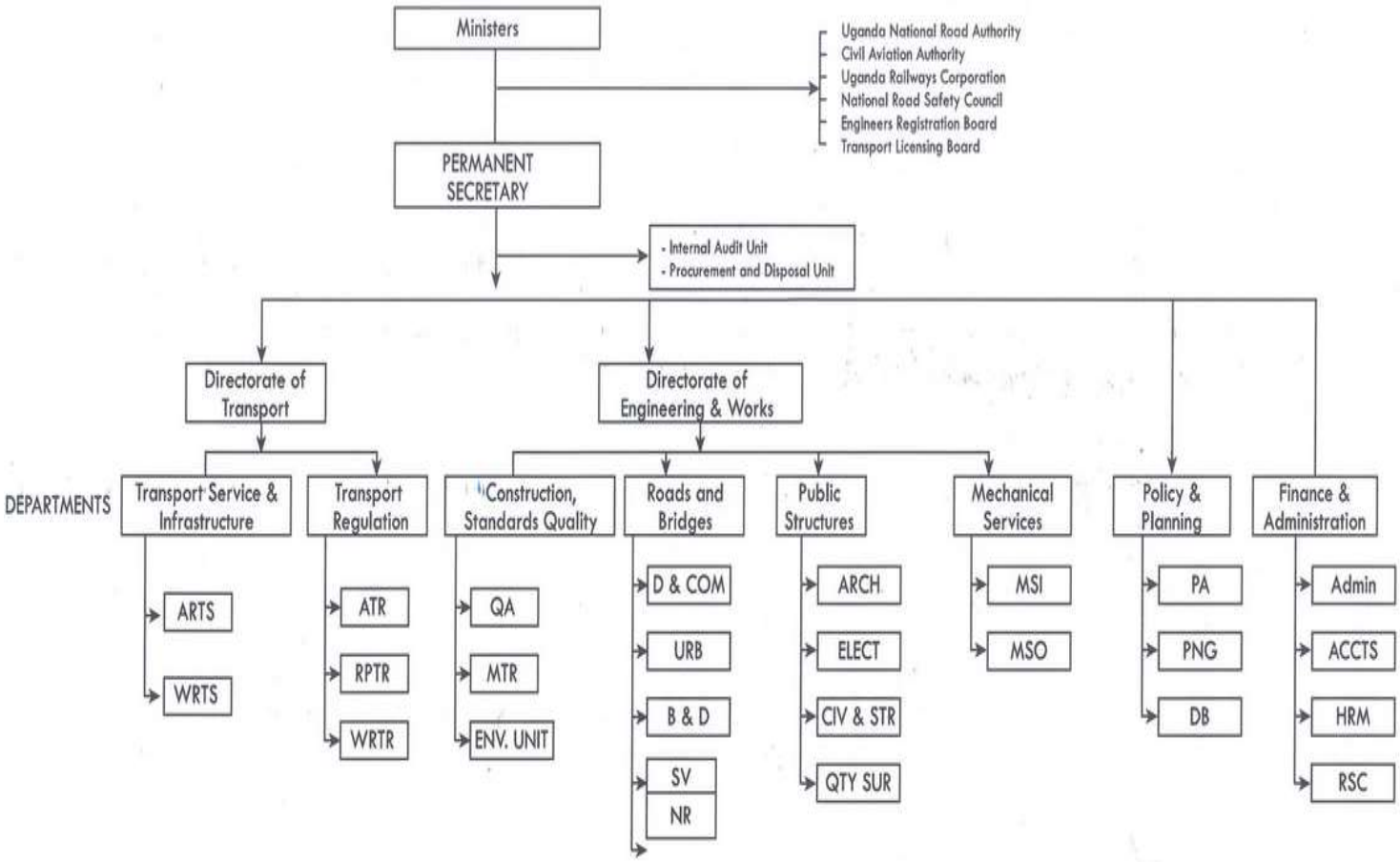
1. Some farmers a long potential water harvesting sites welcomed the idea of collection of such water and if we could empower them that would be great for piloting and marketing the project. This can be done by us providing the know-how to the people (farmers) on which water harvesting technologies to use and how to apply them.

2. Involving the Water for Production department under Ministry of Water and Environment, UNMA (for rainfall data), FAO, IFAD, JICA, CARITAS UGANDA and the Ministry of Agriculture Animal Industry and Fisheries. This could help identify potential funders and partners for this particular project and those that have done work in the same field.
3. Involving the researchers from the academic institutions like Busitema University, Makerere University and others. Such institutions have worked with various organisations and farmer groups so their involvement can bring about more ideas and experiences to the project.

4. Other activities can be initiated to help the success of the New Roads for Resilience: connecting roads, water and livelihoods.

# 7 APPENDIX

## 7.1 Organisational Structure of MoWT




| Transport Services | Transport Regulation | Roads and Bridges | Public Structures | Policy & Planning |
|---|---|---|---|---|
| ARTS - Air & Road Transport Services<br>WRTS - Water & Rail Transport Services | **ATR** - Air Transport Regulation<br>**RPTR** - Roads & Pipeline Transport Regulation<br>**WRTD** - Water & Rail Transport Regulation | **D & COM** - District & Comm. Roads<br>**URB** - Urban Roads<br>**B & D** - Bridges & Drainage<br>**SV** - Surveying Section<br>**NR** - National Roads | **ARCH** - Architecture<br>**ELECTR** - Electrical Engineering<br>**CIV & STR** - Civil Structural Engineering<br>**QTY SUR** - Quality Surveying | **PA** - Policy Analysis<br>**PNG** - Transport & Works Planning<br>**DB** - Database Section |
| | **Construction Standards and Quality Management**<br>**QA** - Quality Assurance<br>**MTR** - Material Test & Research<br>**ENV. UNIT** - Enviroment Unit | **Mechanical Services**<br>**MSI** - Mechanical Services Inspection<br>**MSO** - Mechanical Services Operation | | **Finance & Administration**<br>**Admin** - Administration<br>**HRM** - Human Resource Management<br>**RSC** - Resource Centre |

*Figure 7-1 Organisation structure of Ministry of Works and Transport*

## 7.2 Organisation chart for Directorate of Road Maintenance

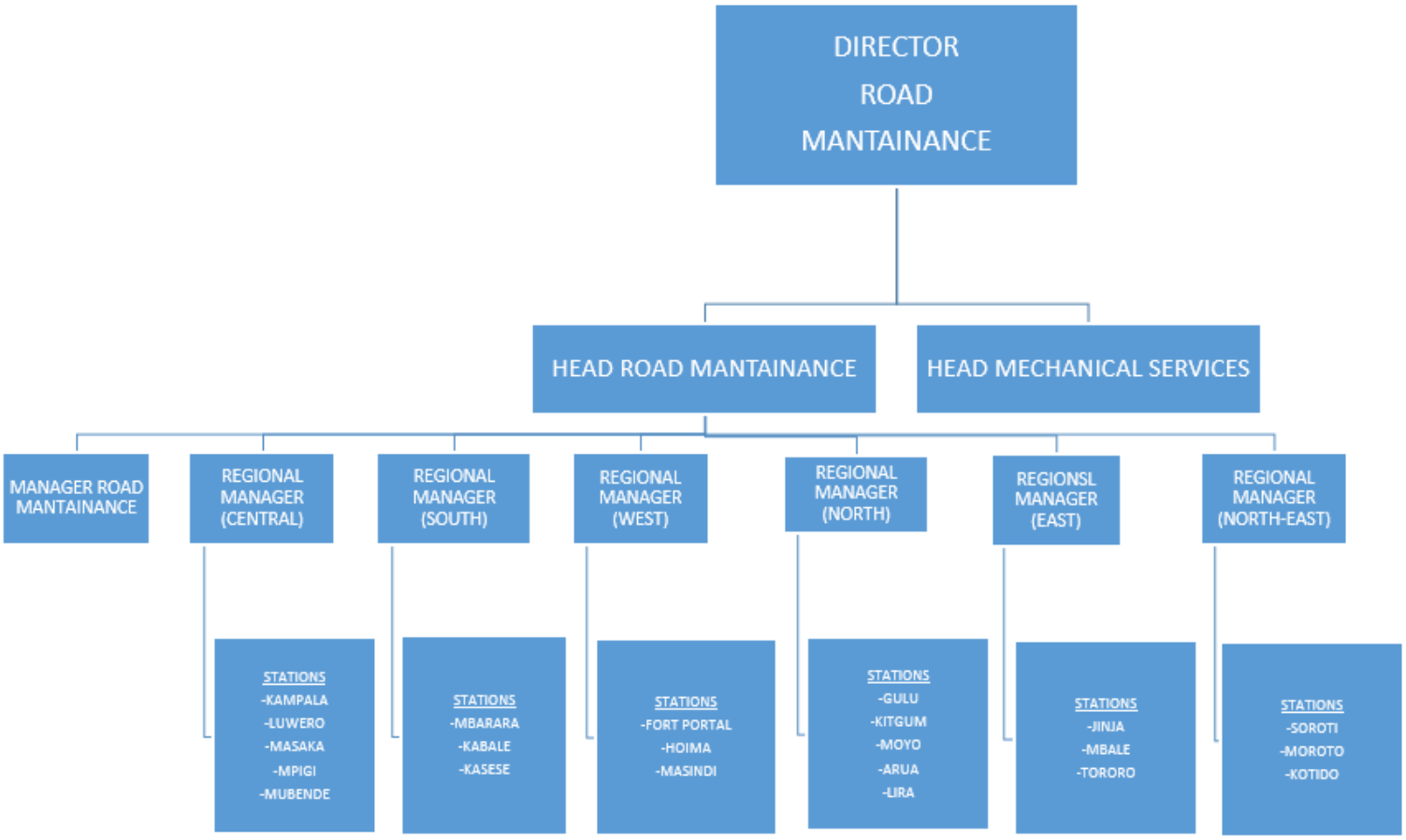



Figure 7-2 Organisation chart for Directorate of Road Maintenance (Source: Eng. Ssonko George, Station Engineer Mbale)

# 8 References

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