INSTITUT D'ENSEIGNEMENT SUPÉRIEUR DE RUHENGERI

FACULTY OF ENGINEERING AND TECHNOLOGIES

DEPARTMENT OF LAND SURVEY

Assessment of soil erosion impacts, Case study: Kinigi, Nyange and Shingiro sectors in Musanze district, Rwanda.

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OUTLINE

- ❑ Introduction
- ❑ Problem statement
- ❑ Research objectives
- ❑ Research Methodology
- ❑ Results
- ❑ Conclusion and
- ❑ Recommendations

I. INTRODUCTION

- Soil erosion is the natural process where soil is displaced or degraded by environmental elements. Rwanda is particularly vulnerable to various natural hazards, including erosion, floods, and droughts.
- In the past ten years, the frequency and severity of these hazards have markedly risen in Rwanda, leading to higher human casualties, and increased economic and environmental losses.
- Rwanda's physical environment is predominantly characterized by steep terrain, particularly from the Eastern to Western regions. This mountainous terrain makes the soil susceptible to water erosion, especially in the northern and western highlands.

II. PROBLEM STATEMENT

- In Rwanda, soil erosion is a prevalent environmental issues leading threats to sustainable agriculture, degraded water quality and decrease soil fertility.
- In the study area has relatively abundant rainfall with high intensity causing soil erosion, water

runoffs from Volcano National Park (VNP) have been particularly an outstanding challenge environment elements in Kinigi, Nyange, and Shingiro sectors of Musanze District for a long time.

- Potential soil erosion risk areas were pinpointed and mapped using the Catchment Restoration Opportunity Mapping (CROM) at the district level. In small-scale erosion risk estimation is still lacking, and there is no universal model that fits all situations, particularly in highly heterogeneous environments.
- This study estimates soil erosion levels in Kinigi, Nyange, and Shingiro sectors using the Revised Universal Soil Loss Equation (RUSLE), which is the most used erosion model based on slope, land use land cover, soil erodibility, rainfall erosivity, and land management practices.

III. RESEARCH OBJECTIVES

3.1. General objective

The general objective of this study is to assess soil erosion impacts in Kinigi, Nyange, and Shingiro sectors in Musanze District, Rwanda using the RUSLE model. This aims to provide decision-makers with insights for balanced land management and establish mitigation measures of soil erosion.

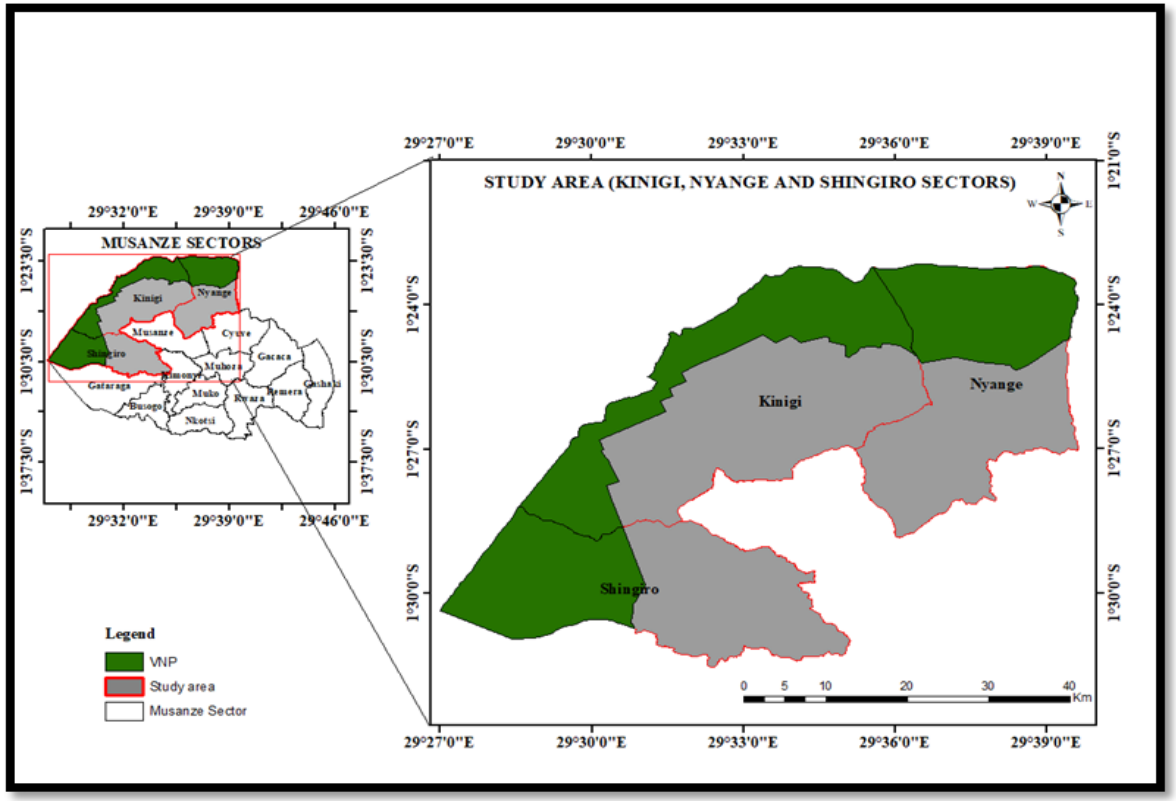
3.2. Specific objectives

- To estimate soil erosion levels in the Kinigi, Nyange, and Shingiro sectors using the RUSLE model.
- To evaluate the impacts of soil erosion on agriculture and soil nutrients in the Kinigi, Nyange, and Shingiro sectors.
- To evaluate the impacts of soil erosion on infrastructure in the Kinigi, Nyange, and Shingiro sectors.

❖ To assess the impact of soil erosion on the overall well-being of the community and propose recommendations.

IV. RESEARCH METHODOLOGY

4.1. Study area description



- This study is conducted in the three sectors.
- It located between 1.3833° S to 1.7167° S latitude and 29.5667° E to 29.7500° E longitude.
- It is received annually rainfall between 2,000 and 3,000 mm.
- It is used Land management practice, where contouring ranged from 0.55 to 1, strip cropping varied from 0.27 to 0.5, and terracing ranged from 0.1 to 0.2.
- In this study area, Slope has been the terrain's nature affecting runoff characteristics, recharge, and infiltration capacity of water.
- It has soil properties closely linked to erodibility, including sand, silt, clay fractions, and organic carbon content.
- It has agricultural practices and land management on soil erosion.

4.2. Data collection

N0	DATA	SOURCES	USE
1	Digital Elevation Model (DEM)	USGS Earth Explorer	LS and P factor
2	Land use land cover data	Images Downloaded / USGS Earth Explorer	C factor
3	Soil data	• Rwanda Agriculture Board (RAB) • Soil samples collected	• K factor • Soil nutrient contents in areas of high and low erosion
4	Rainfall data	Meteo Rwanda	R factor
5	Administrative shape files	RHA	Study area boundaries
6	Socio-economic data	Collected from 385 households	Estimation social economic impacts

4.3. Flow diagram for estimating soil erosion levels using the (RUSLE) model

A = R * K * LS * C * P

Where,

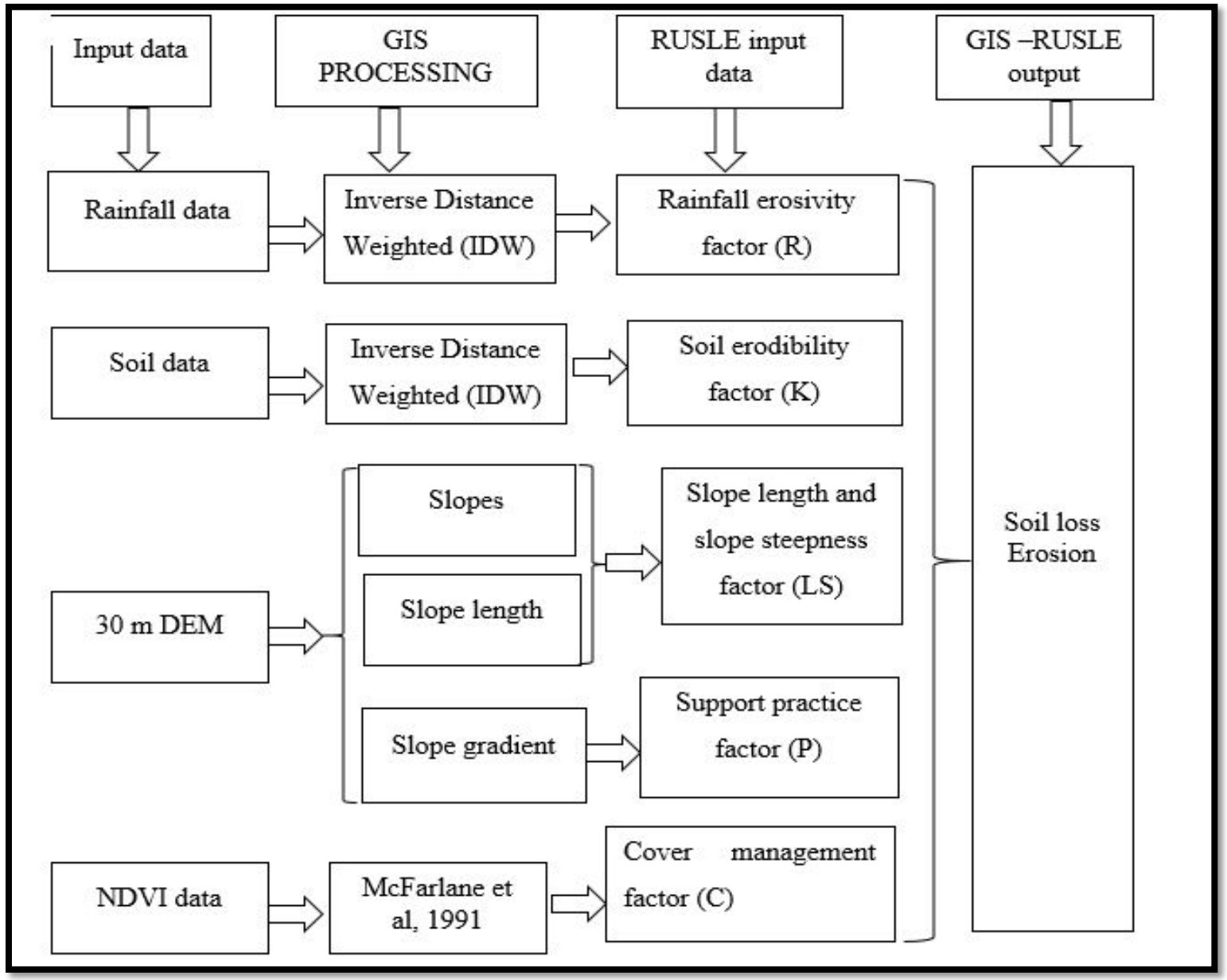
R: Rainfall erosivity factor

K: Soil erodibility factor

LS: Slope length and steepness factor

C: Cover management factor

P: Support practice factor



5. RESULTS

5.1. Annual soil loss of Kinigi, Nyange and Shingiro Sectors

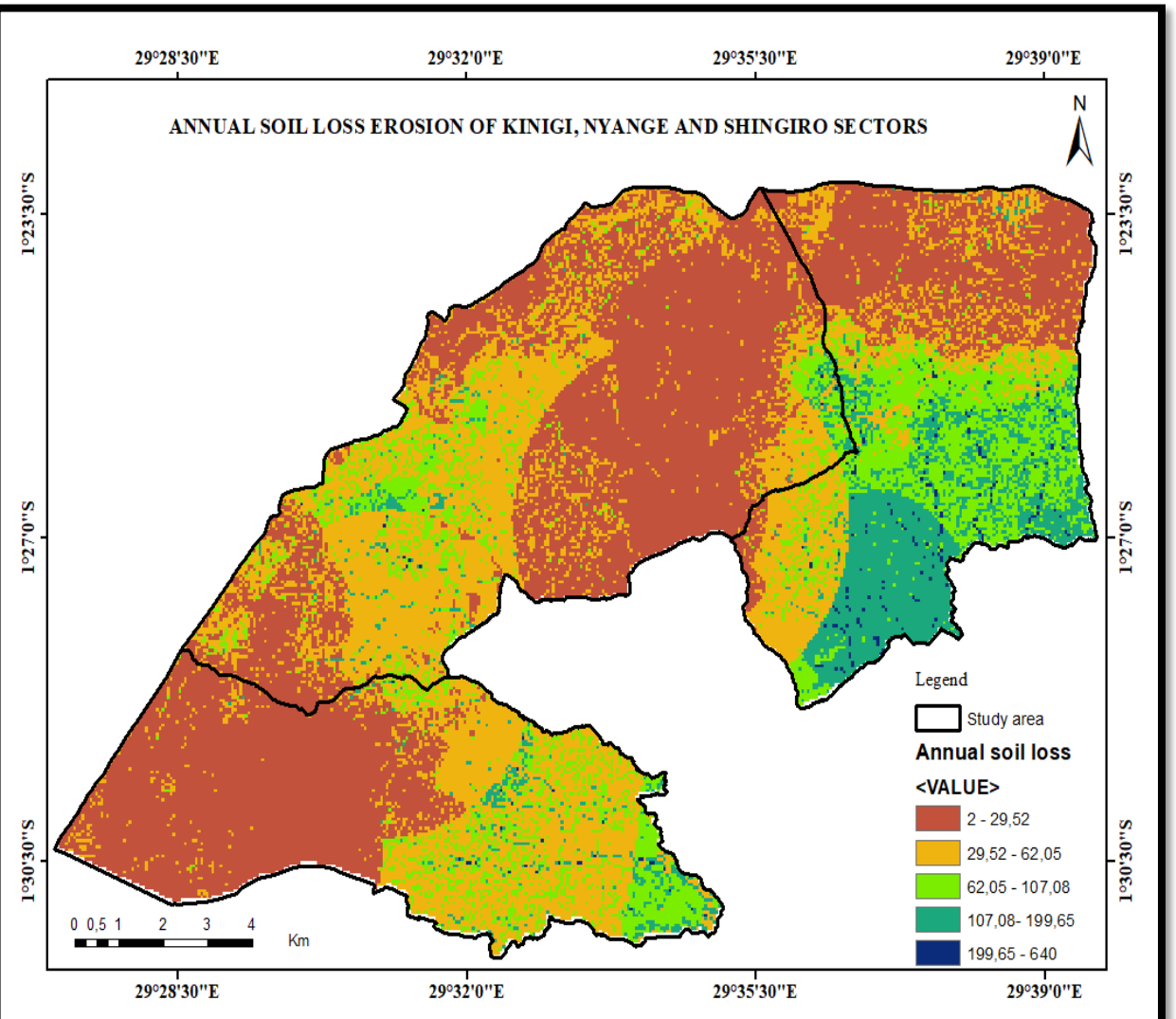
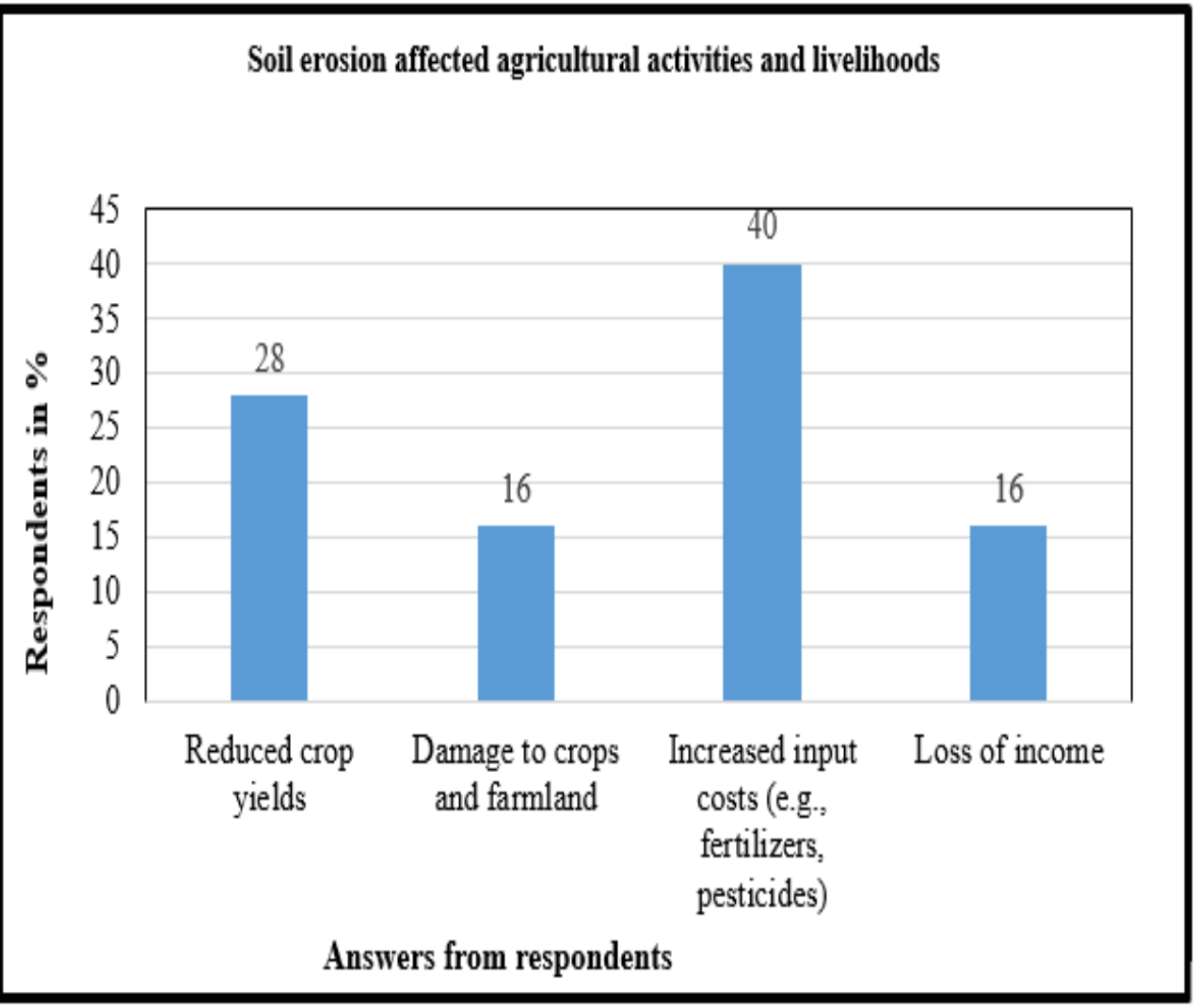


Table of annual soil loss in five classes

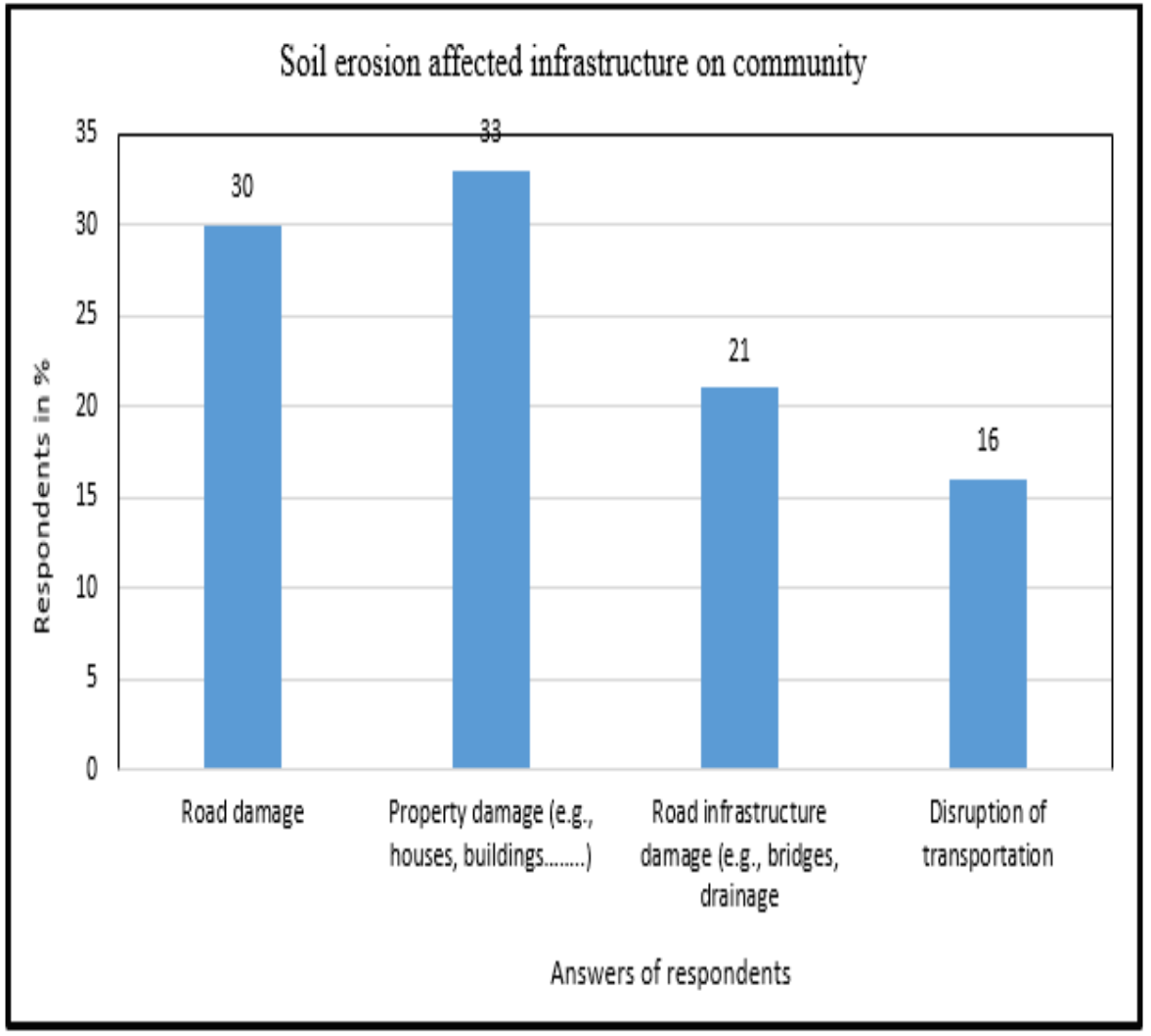
Yearly soil erosion rates (t ha-1year-1)	Class category	Area (ha)	Area (%)
2 - 29,52	Low	21504	44,62
29,52 - 62,05	Moderate	15238	31,62
62,05 - 107,08	High	7046	14,62
107,08- 199,65	Very high	4173	8,66
199,65 - 640	Severe	234	0,49

RESULTS, cont'

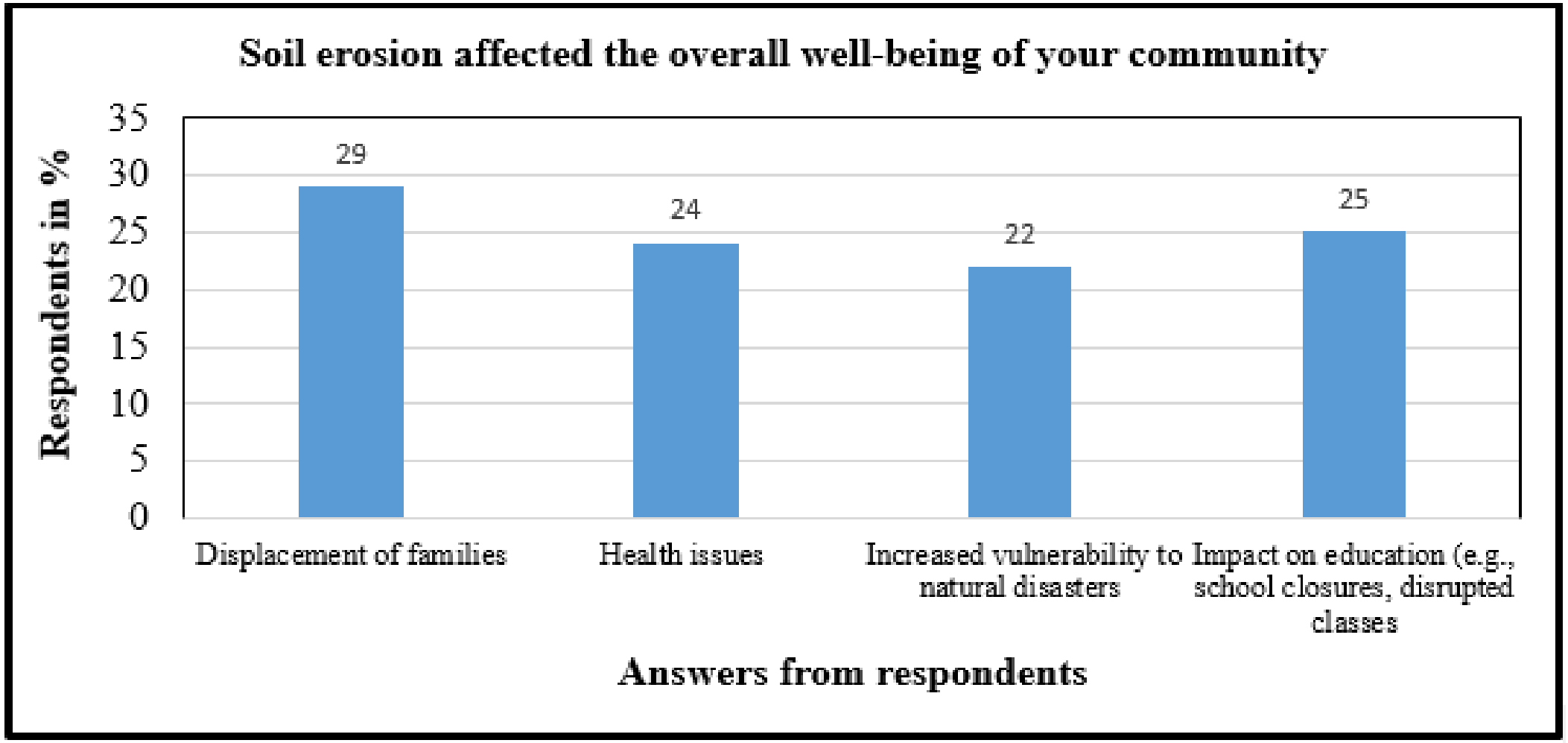
5.2. Soil erosion affects agriculture and livelihoods in the study area



5.3. Infrastructure affected by soil erosion in Kinigi, Nyange, and Shingiro



5.4. Effect of soil erosion on community overall well-being



RESULTS, cont'

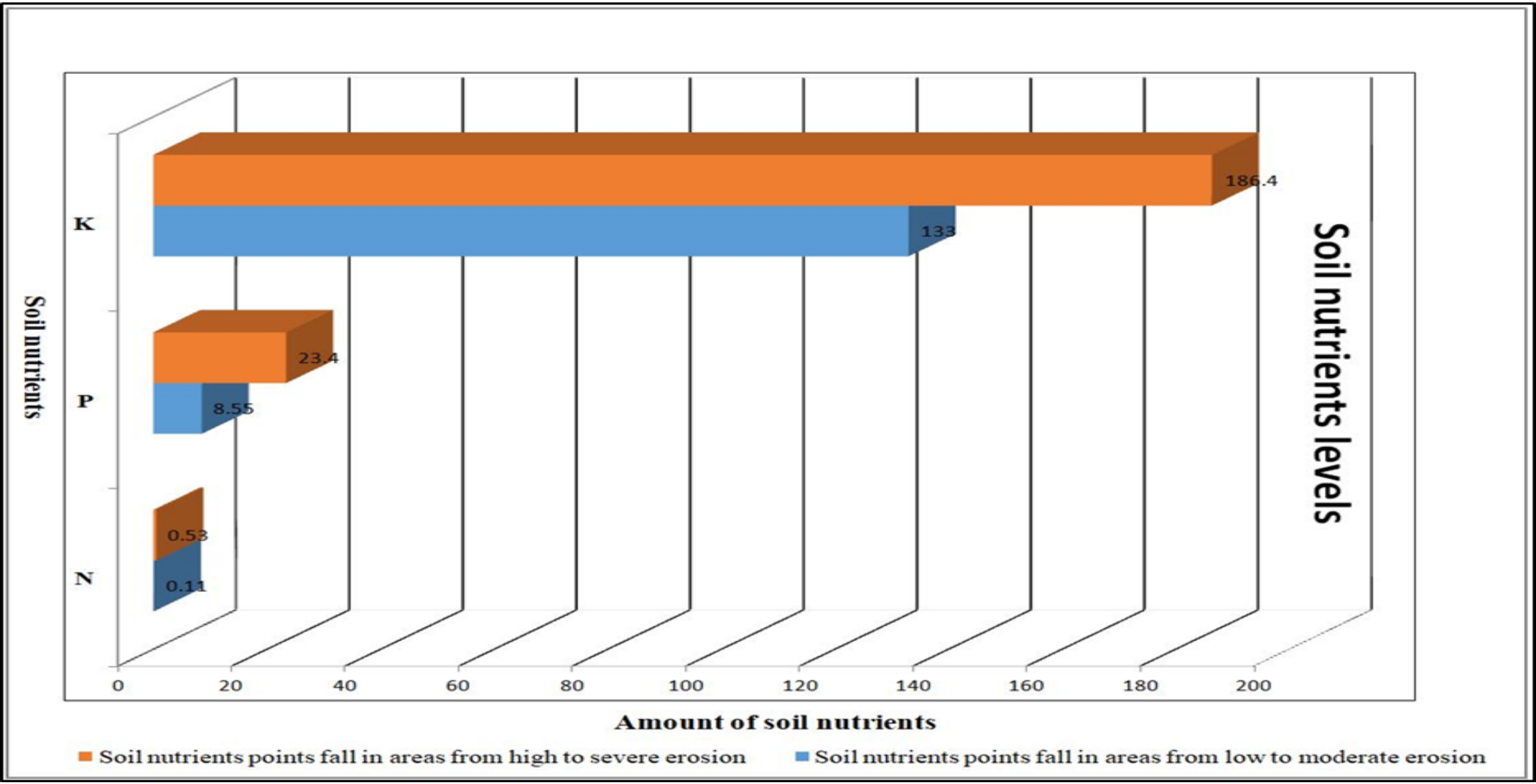
Soil nutrient points fall in areas from high to severe erosion

No	N (%)	P(ppm)	K(cmol $_{(+)}$/Kg)	Corresponding soil loss (t ha-1year-1)
1	0.25	20.3	88	74.56-134.60
2	0.24	9.8	187	134.60-254.70
3	0.19	27.1	536	74.56-134.60
4	0	53.2	64	74.56-134.60
5	0	6.6	57	74.56-134.60
Total	0.68	117	932	
Average	0.53	23.4	186.4	

Soil nutrient points fall in areas from low to moderate erosion in the study area

No	N (%)	P (ppm)	K ($cmol_{(+)}$/Kg)	Corresponding soil loss (t $ha^{-1}year^{-1}$)
1	0.22	4.6	64	29.52-74.56
2	0.21	5.5	103	29.52-74.56
3	0	15.5	282	29.52-74.56
4	0	8.6	85	29.52-74.56
Total	0.43	34.2	532	
Average	0.11	8.55	133	

Flow chart of soil nutrient levels



6. Conclusions

- The study identified significant annual soil erosion variations in the study area. Nyange experiences high to severe erosion, while Kinigi and Shingiro have moderate to high erosion rates.
- The study also found that soil nutrient levels are higher in areas of soil sediments deposition (severe erosion), with potassium showing the most significant difference, followed by phosphorus and nitrogen.
- The soil erosion impacts on social economic and agriculture livehoods in the study area include increasing input costs (40%), property damage (33%) and overall being (29 %).

7. RECOMMENDATIONS

- Implement soil conservation techniques like contour farming and terracing in high erosion areas.
- Increase tree planting to enhance soil stability and promote sustainable agricultural practices in moderately eroded regions.
- Develop infrastructure to manage water flow in severe erosion zones and educate local communities to involve them in erosion control measures.

THANK YOU FOR YOUR KIND ATTENTION