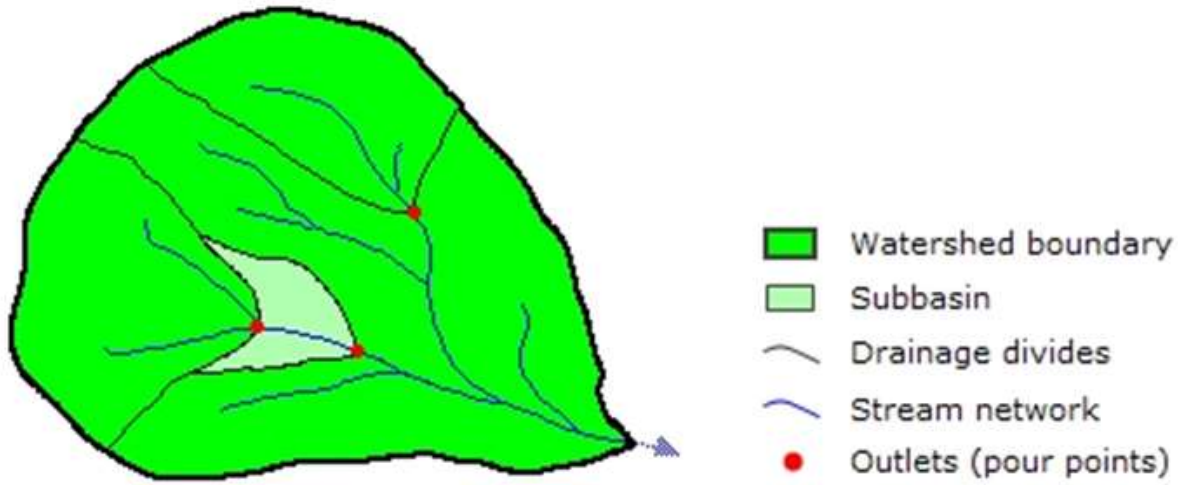
DEVELOPMENT OF AN INTEGRATED CATCHMENT MANAGEMENT PLAN FOR Pyeng, PLATEAU STATE

Kehinde Ogunmola, PhD

NCRS CONSULT

INTRODUCTION

The Pyeng Catchment is urban and characterized by abandoned mine ponds and a few active artisanal mining which requires explicit consideration of uncertainties about the sources of water pollution. Parts of River Kaduna also passes through this catchment and the problem of encroachment into flood plains due to urbanization is common.



A watershed/catchment is the upslope area that contributes flow—generally water—to a common outlet as concentrated drainage. It can be part of a larger watershed and can also contain smaller watersheds, called subbasins. The boundaries between watersheds are termed drainage divides. The outlet, or pour point, is the point on the surface at which water flows out of an area. It is the lowest point along the boundary of a watershed.

- An urban catchment has diverse benefits associated with it - economic, natural, recreational, and cultural - with natural systems within the catchment having to absorb a number of uses associated with these benefits.
- Soil erosion also poses a threat to watersheds and the environment. According to the FAO, the world's cultivated soils - meaning soils that have been rearranged - have lost between 25 and 75 percent of their original carbon stock, which has been released into the atmosphere in the form of carbon dioxide.
- Research reports (Igbokwe *et al.,* 2008; Jimoh, 2008; Abu, 2011) have established relationships between human activities and soil erosion, indicating that both affect each other significantly.

- Erosion is one of the physical manifestations of environmental degradation, which can be facilitated by causative factors of wind and water. However, the most prominent of these factors is soil erosion by water, and its rate and magnitude are controlled by the factors of rainfall intensity and run-off, soil erodibility, slope gradient and length, and vegetation cover (Wall *et al.,* 1987).
- The performance of watersheds and their ecosystem are being threatened by the emergence of global warming and climate change. This has caused increase in pattern of precipitation, runoff, erosion, siltation and pollution etc.
- According to Giddens (2008), climate change has moved to the center stage of public concern in a remarkable way and in a very short space of time.

Rational For an Integrated Catchment Management Plan Approach

- The model adopted for generating a catchment management Plan for Pyeng catchment is a participatory approach based on an open stakeholder engagement that enables all those with an interest in the catchment to interact and work effectively together so as to achieve resource sustainability, deliver improvements to the catchment and ensure future access to natural resources to all that depend on the catchment and overall promote development.

- A well-integrated Management Plan is aimed at balancing the use of land, biological and water resources within a catchment, in a sustainable way, by promoting co-operation and co-ordination at all levels of Government, in collaboration with the entire community on management of these resources (Bunn and Mouritz, 1995).

- The primary aim of an ICMP is to show how a catchment will be sustainably managed and protected, how devastated areas can be reclaimed or how to slow down the environmental menace and eventually put an end to it.

- Catchments are independent of political and administrative boundaries and consist of natural and human modified ecosystems with a characteristic configuration of topography, geology, soils, land use and vegetation.

- This approach is ‘Integrated’ because the ICMP integrates or combines characteristics such as ecology, hydrology, landuse, engineering, public health, socio-economic characteristics, indigenous knowledge and expectations of the people. The ‘catchment’ approach makes sure that the combined effects emanating from all the activities within the catchment are reflected in the plan.

Objectives of the ICMP

- Delineate the catchment using a digital elevation model (DEM).
- Describe the existing status of the catchments
- Identify the environmental and social issues/risks associated with the existing conditions
- Develop a plan for mitigating environmental and social risks
- Define technical assistance programs that could strengthen environmental management capability
- Provide an implementation schedule for measures that must be carried out
- Provide a synoptic view of the current state of each catchment.

Threats to address

- Managing high surface water run-off
- Soil erosion
- Poor waste management practices that can contribute to clogging of drains, flooding, and land degradation
- Inappropriate land uses contributing to sedimentation, flooding and land degradation
- High poverty rates, especially among women and vulnerable groups
- Adverse impact of climate change on the environment
- Lack of Community Education and Awareness
- Habitat Destruction and Fragmentation
- Water pollution

Location of the Catchment

The catchment is located in the northern part of Plateau State (fig 1).

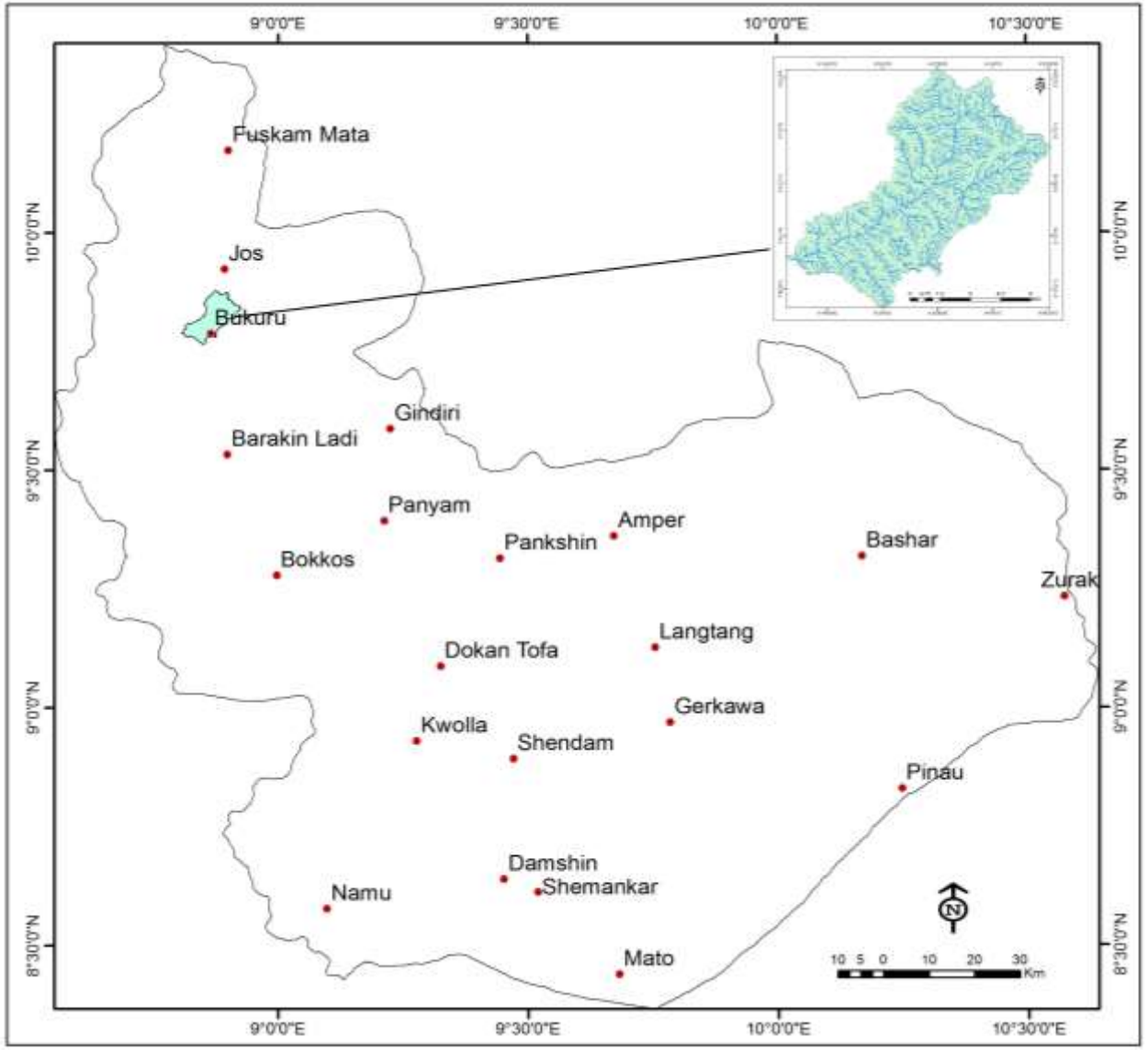


Figure 1. Map of Plateau State (inset: Pyeng Catchment)

Description of the catchment

The catchment is an urban catchment. It is bounded by the following coordinates with a perimeter of about 60 km and an area of about 7044 Hectares (fig 2). It is located in Jos South LGA of Plateau State.

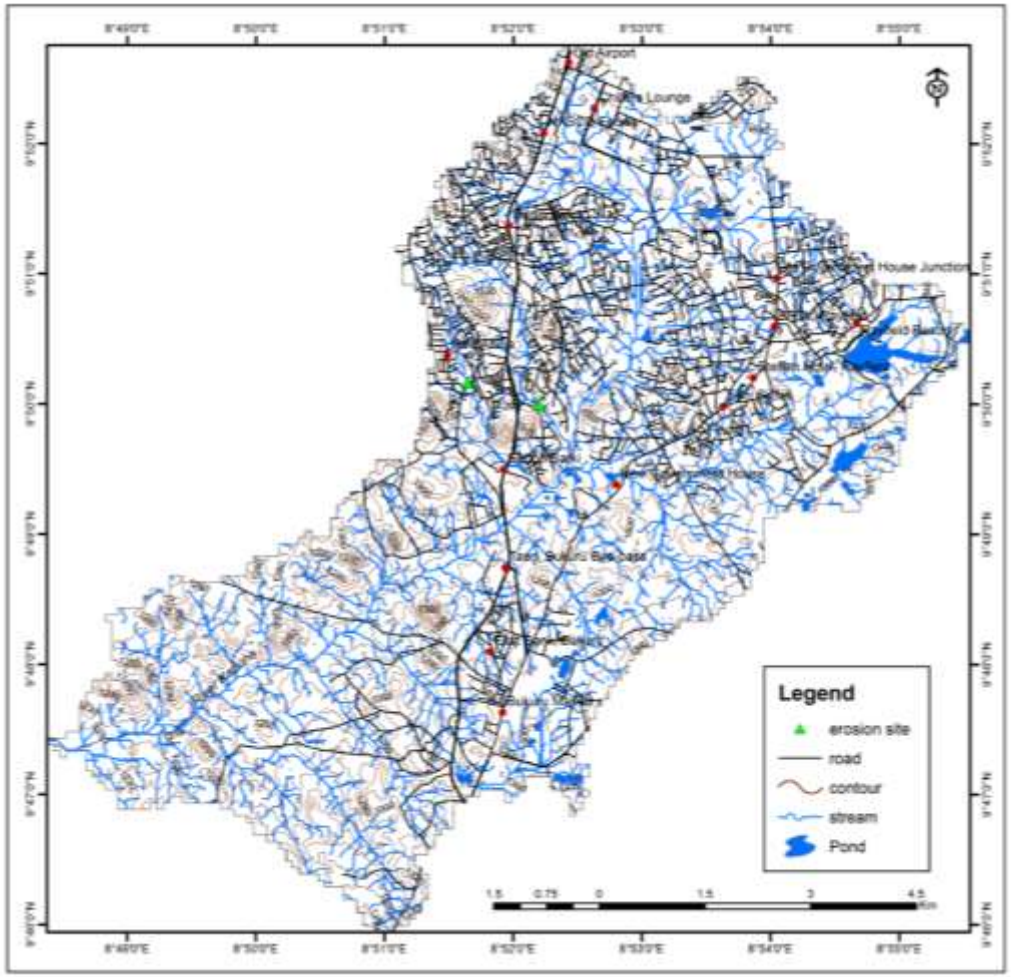


Figure 2. Topographic map of the Pyeng Catchment

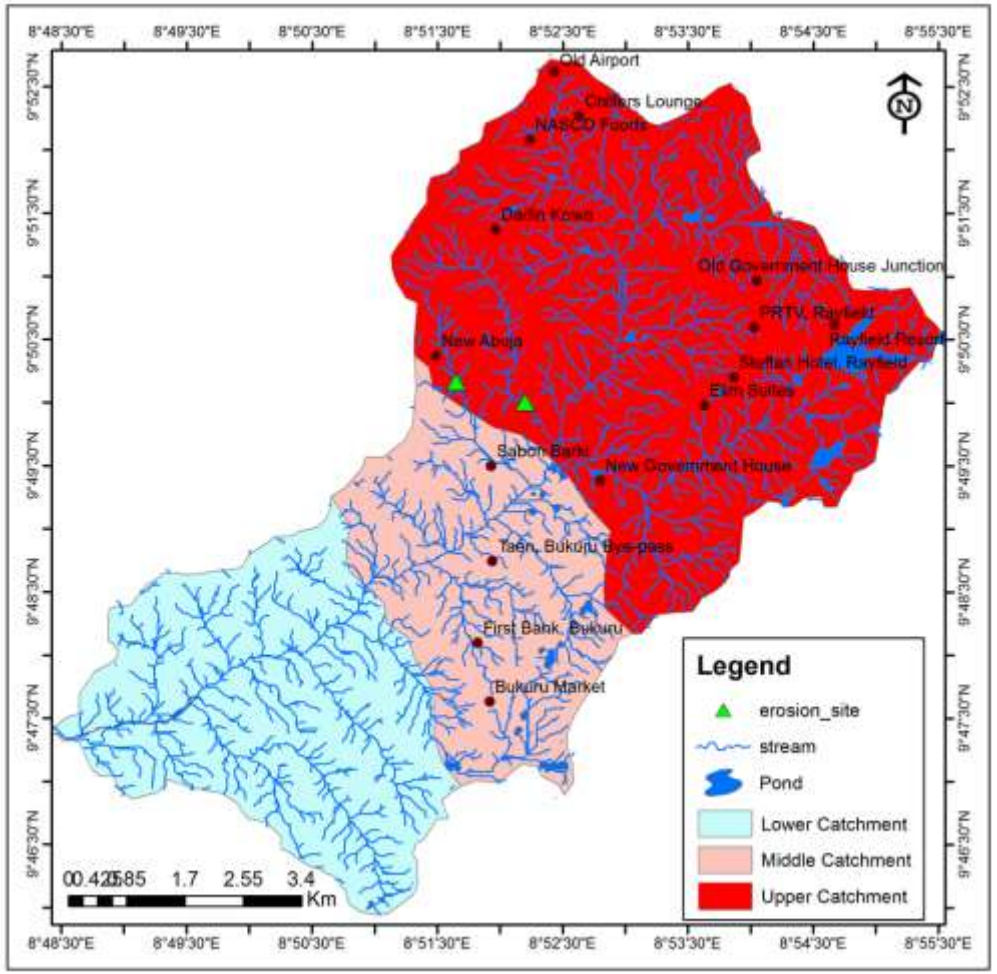


Figure 3. Sub-divisions of the Pyeng Catchment

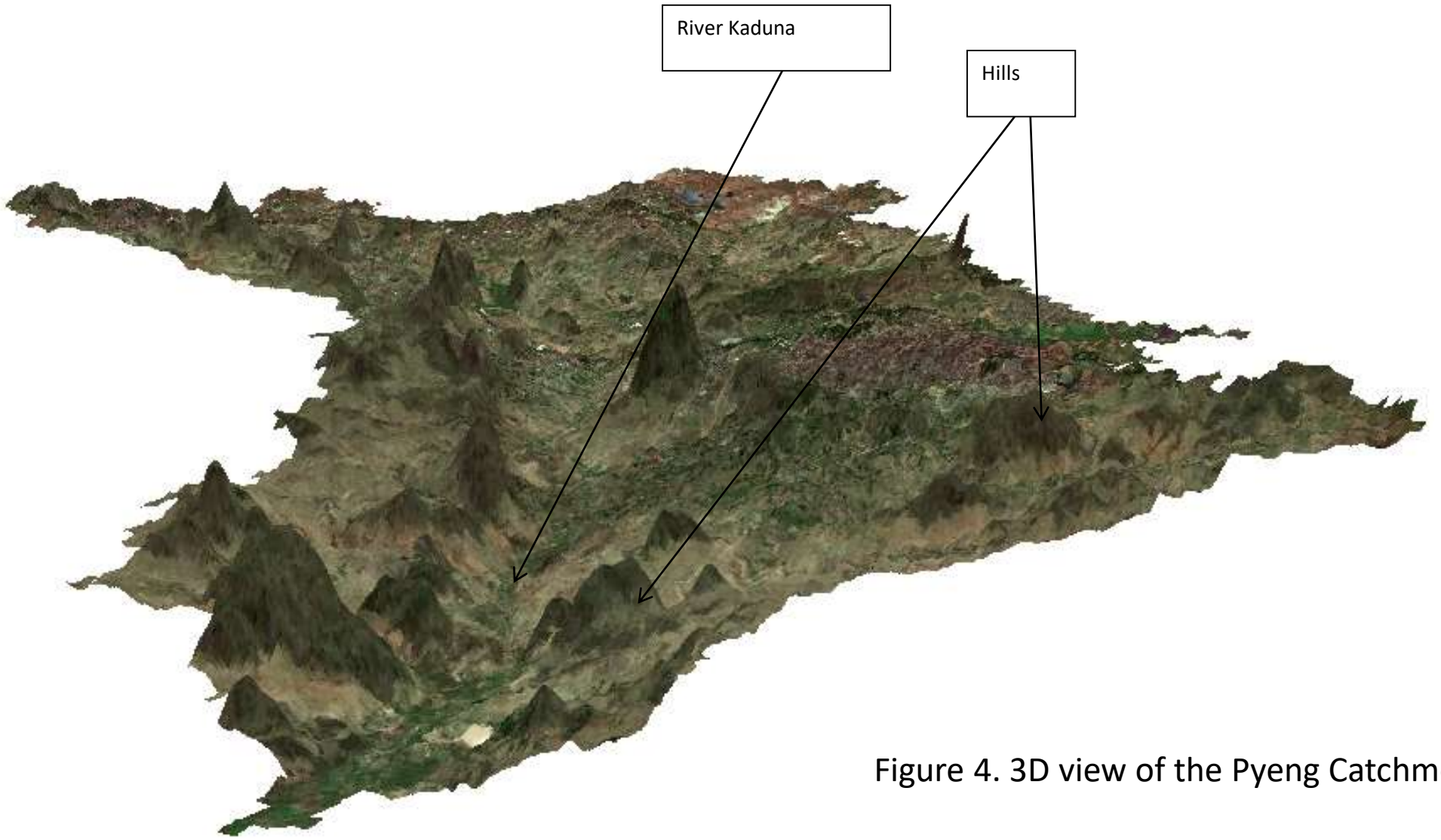


Figure 4. 3D view of the Pyeng Catchment

Hydrology

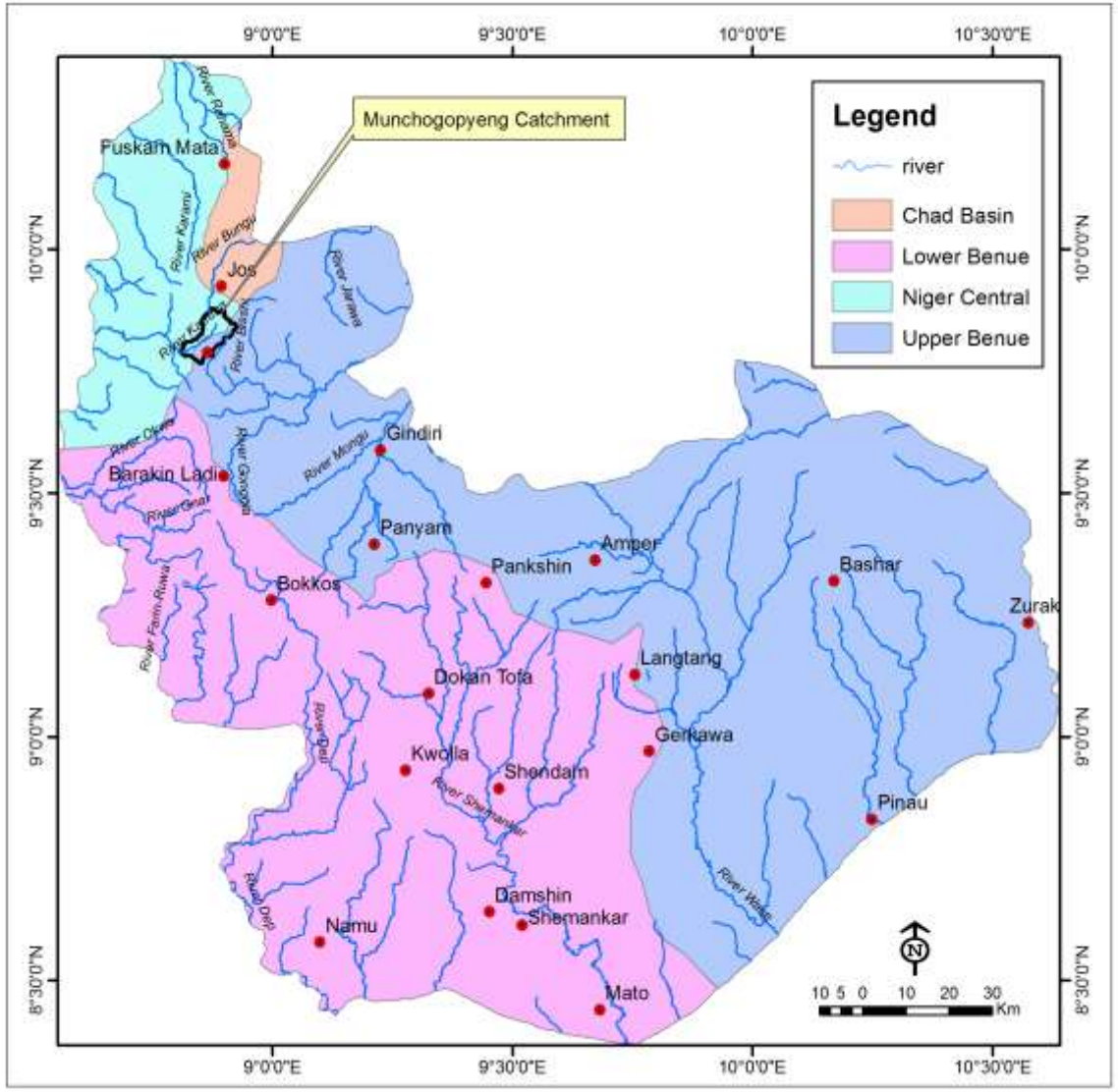


Figure 5. Hydrological Map of Plateau State showing the location of the Pyeng Catchment (source: JICA, 2014)

Plateau State falls within four (4) Hydrological areas namely HA-8: Chad Basin., HA-4: Lower Benue, HA-2: Niger Central and HA-3: Upper Benue. Pyeng Catchment falls within HA-3: Upper Benue and HA-2: Niger Central Hydrological areas (fig 5).

Geology

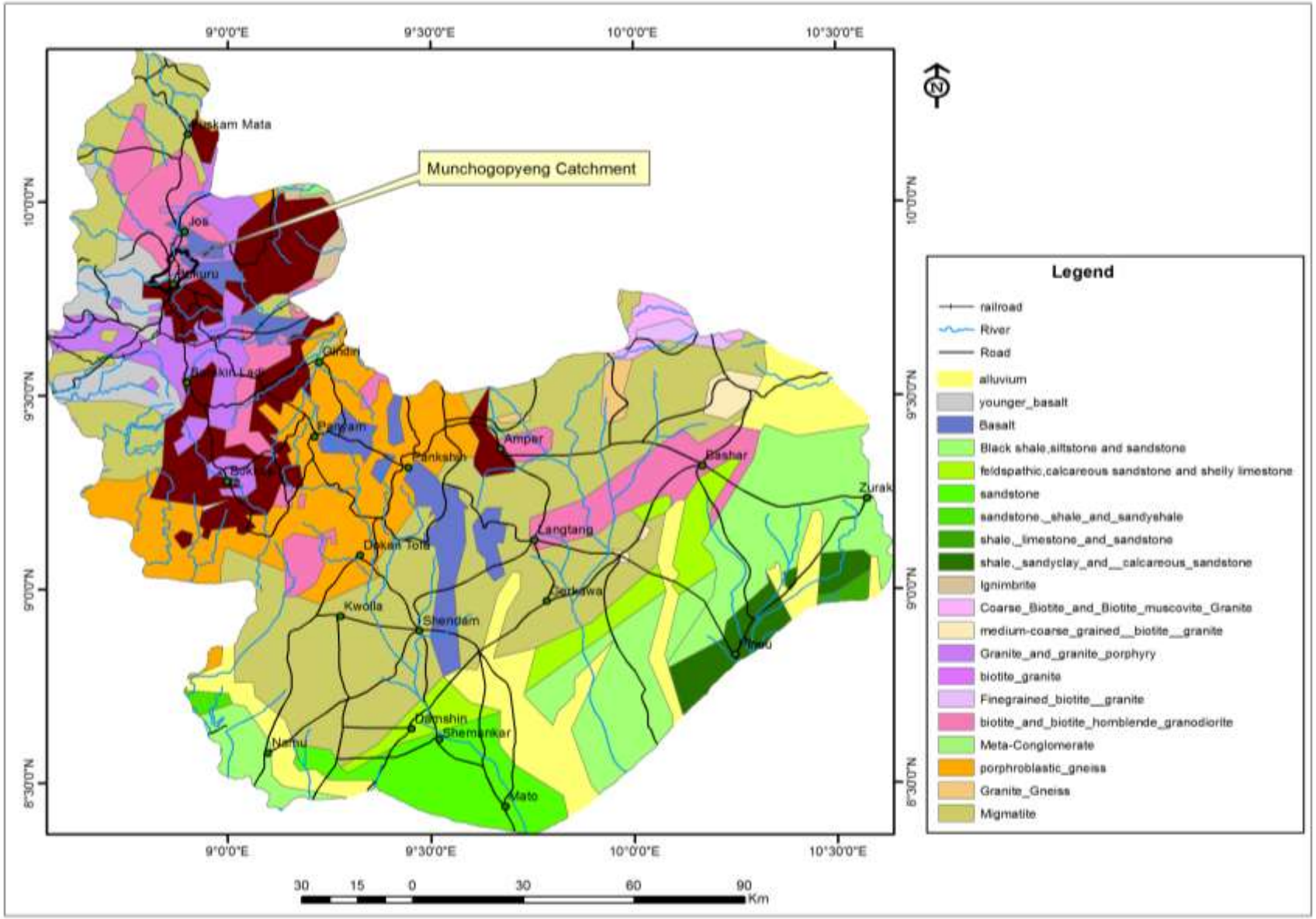


Figure 6. Geological map of Plateau State showing the Pyeng catchment

Vegetation

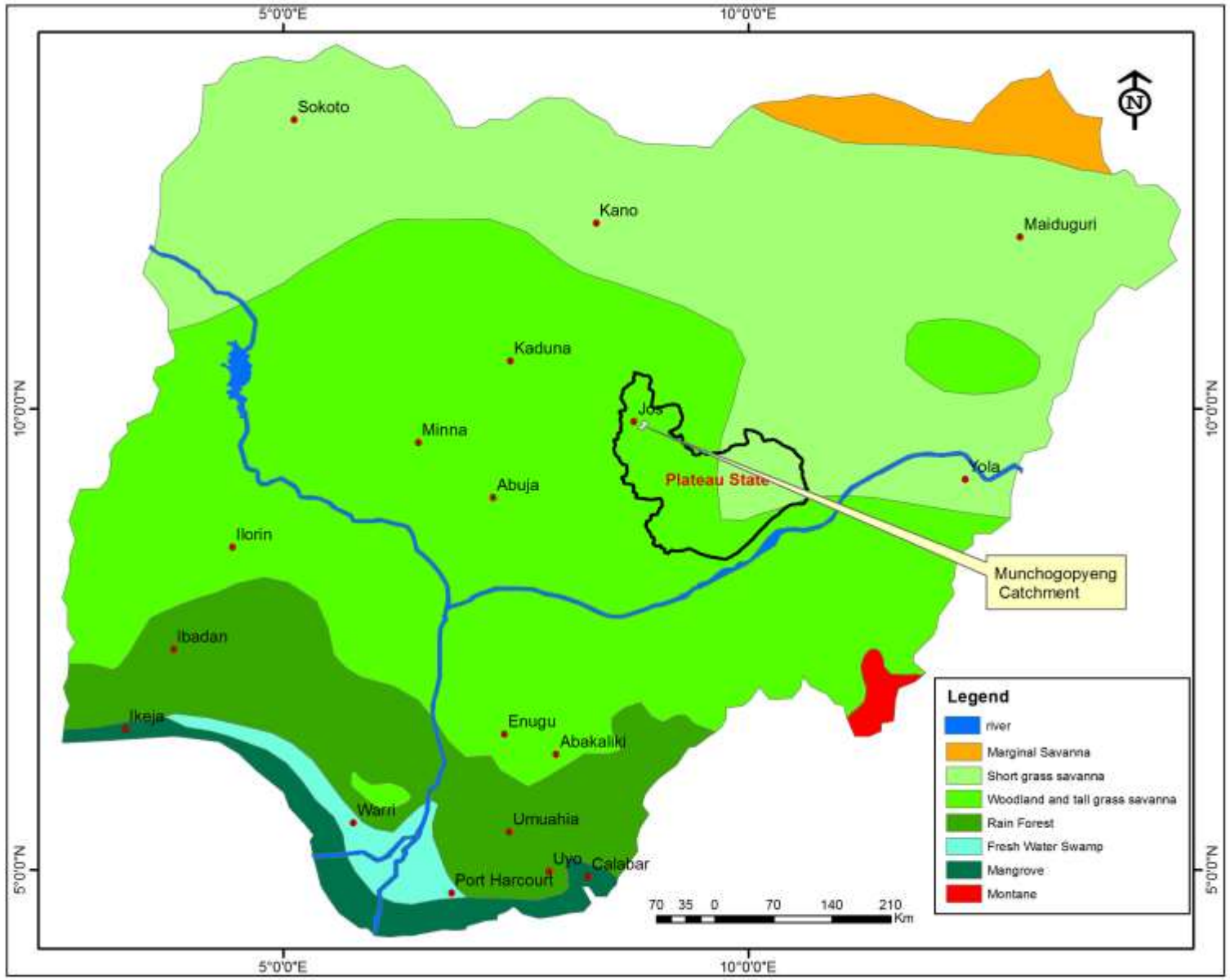


Figure 7. Vegetation map of Nigeria showing Plateau State and the location of the catchment (source: Public domain)

Bacterial Water Quality

S/N	SAMPLE ID	LOCATION	CATCHMENT	COORD (N)	COORD	PLATE COUNT	BACTERIAL COUNT
1	MCH 01	BUKURU LOWCOST STREAM	LOWER	9.8140278	8.860555556	86	92
2	MCH 02	WITT STERAM	LOWER	9.8185	8.86725	91	86
3	MCH 03	RAT CONFLUENCE	LOWER	9.8222778	8.870805556	89	71
4	MCH 04	RAT HAND DUG WELL	LOWER	9.8220556	8.869611111	78	44
5	MCH 05	Pyeng STREAM	MIDDLE	9.8273333	8.873944444	81	72
6	MCH 06	LAYON STREAM	MIDDLE	9.8348333	8.868083333	89	63
7	MCH 07	ZARMAGANDA STREAM	MIDDLE	9.847	8.866611111	99	54
8	MCH 08	ZUMJI STREAM, SABON BARKI JUNCTION	MIDDLE	9.8254167	8.866416667	93	61
9	MCH 09	BUILDING MATERIAL STREAM (LOMAY)	UPPER	9.8304444	8.863277778	98	72
10	MCH 10	BUILDING MATERIAL STREAM (OPEN UNIVERSITY)	UPPER	9.8358889	8.860888889	72	39
	WHO/NSDWQ						**0/10**

Table 1. Plate and Coliform count in waters of Pyeng Catchment Area

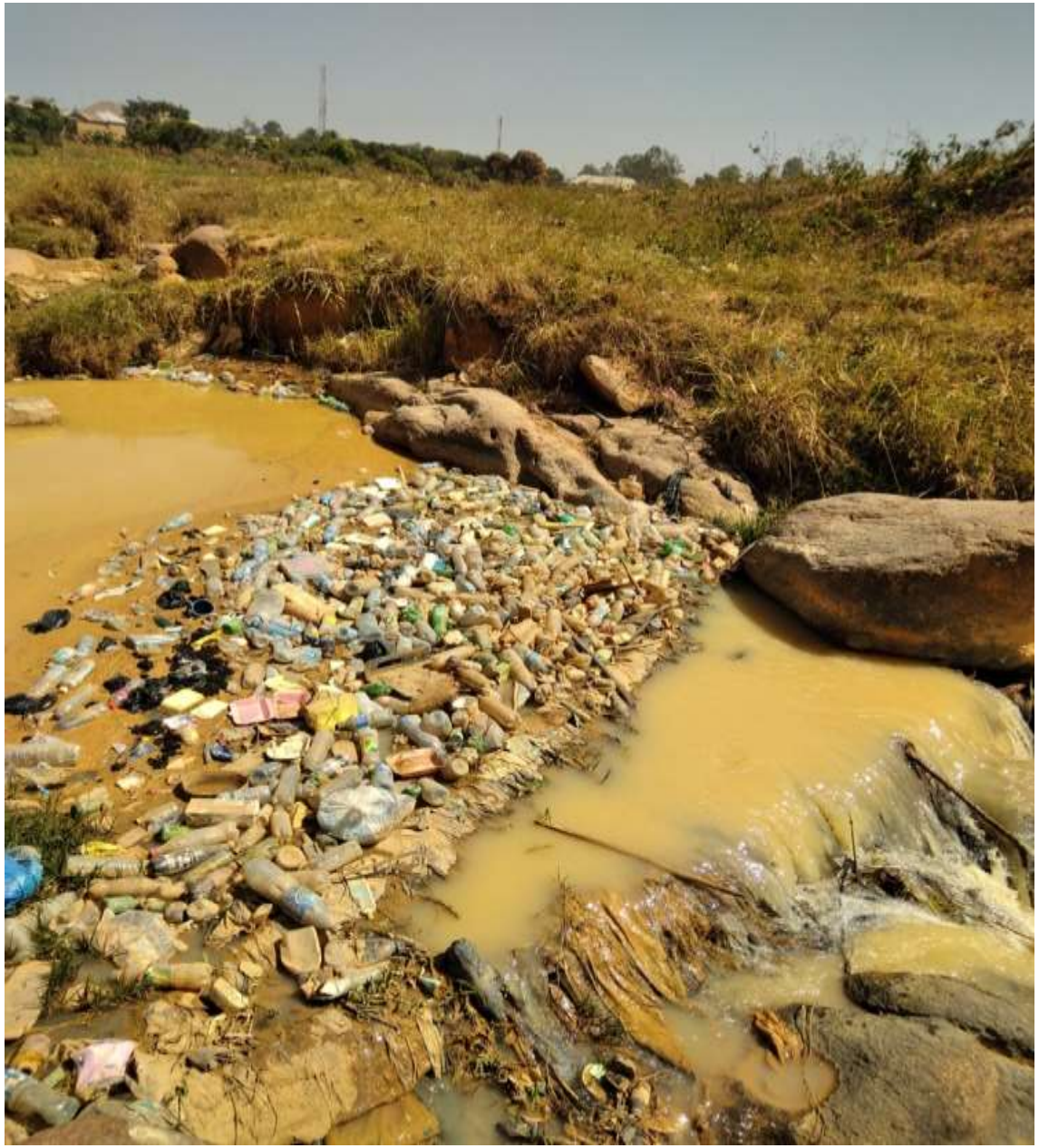


Plate 1. Plastic bottles, polyethene bags and rags within one of the Pyeng streams. Open defecation is a common practice along the channel.

Table 2. Isolated micro-organisms in water samples

									Triple Sugar Ion Agar Slant				
Sample No.	**Catchment**	**Catalase**	**Coagulase**	**Indole**	**Urease**	**Oxidase**	**Citrate**	**Motility**	**Slope**	**Butt**	**H_{25}**	**Gas**	**Microorganism Isolated from the Samples**
MCH 01	LOWER	+	+	+	-	-	+	-	y	Y	-	+	*Staphylococcus aureus Escherichia coli,*
MCH 02	LOWER	-	-	+	+	-	+	-	Y	Y	-	+	*Escherichia coli, Proteus spp*
MCH 03	LOWER	-	-	+	+	-	+	-	Y	Y	-	+	*Escherichia coli, Proteus spp*
MCH 04	LOWER	+	+	+	-	-	+	-	Y	Y	-	+	*Staphylococcus aureus, Escherichia coli,*
MCH 05	MIDDLE	-	-	+	+	-	-	-	Y	Y	-	+	*Escherichia coli, Proteus spp*
MCH 06	MIDDLE	+	+	+	-	-	+	-	Y	Y	-	+	*Staphylococcus aureus, Escherichia coli,*
MCH 07	MIDDLE	+	-	+	-	-	+	-	Y	Y	+	+	*Streptococcus faecalis, Escherichia coli, Salmonella typhi.*
MCH 08	MIDDLE	+	+	-	+	-	+	-	r	Y	-	-	*Staphylococcus aureus, Proteus spp*
MCH 09	UPPER	+	+	+	+	-	+	-	Y	Y	-	+	*Staphylococcus aureus, Escherichia coli, Proteus spp*
MCH 10	UPPER	+	+	+	-	-	+	-	Y	Y	-	+	*Staphylococcus aureus, Escherichia coli,*

Physical and Chemical Quality of Water Samples

Table 3. Physico-Chemical Parameters of water samples

S/N	SAMPLE ID	LOCATION	CATCHMENT	COORD (N)	COORD (E)	COLOUR	ODOUR	TEMP	PH	TDS	EC	Na	Ca	Mg	K	Cl	NO_3	SO_4	ALK
1	MCH 01	BUKURU LOWCOST STREAM	LOWER	9.81402778	8.860555556	cloudy	odourless	22.5	7.55	36	72	7.8	7.15	1.33	4.59	20	13.2	20.8	40
2	MCH 02	WITT STERAM	LOWER	9.8185	8.86725	cloudy	odourless	21.2	7.5	47	94	8.58	6.44	1.85	4.64	20	8.8	20	40
3	MCH 03	RAT CONFLUENCE	LOWER	9.82227778	8.870805556	partly cloudy	odourless	22.6	7.6	39	78	7.77	6.57	1.18	4.21	20	6.6	17	40
4	MCH 04	RAT HAND DUG WELL	LOWER	9.82205556	8.869611111	colourless	odourless	25.8	5.3	27	54	7.7	5.85	1.08	4.42	15	22	2.9	5
5	MCH 05	PYENG STREAM	MIDDLE	9.82733333	8.873944444	colourless	odourless	23.2	7.66	56	112	10.2	7.1	1.37	5.01	20	17.6	8.5	40
6	MCH 06	LAYON STREAM	MIDDLE	9.83483333	8.868083333	colourless	odourless	27.8	7.61	103	206	12.7	9.75	2.06	7.01	25	17.6	3.8	75
7	MCH 07	ZARMAGANDA STREAM	MIDDLE	9.847	8.866611111	colourless	odourless	25.5	7.44	106	212					30	8.8	4.9	90
8	MCH 08	ZUMJI STREAM, SABON BARKI JUNCTION	MIDDLE	9.82541667	8.866416667	colourless	odourless	26.3	7.92	41	82					20	8.8	7.5	25
9	MCH 09	BUILDING MATERIAL STREAM (LOMAY)	UPPER	9.83044444	8.863277778	colourless	odourless	26.8	7.01	35	70					15	26.4	5.7	20
10	MCH 10	BUILDING MATERIAL STREAM (OPEN UNIVERSITY)	UPPER	9.83588889	8.860888889	colourless	odourless	27.2	6.81	41	82					20	8.8	3.8	30
		WHO*/NSDWQ				**Unobjectionable**	**Unobjectionable**	**Ambient**	**6.5 - 8.5**	**500**	**1000**	**200**					**50**	**100**	

Table 4. Trace Element Concentration in Water Samples

S/N	SAMPLE ID	LOCATION	CATCHMENT	COORD (N)	COORD (E)	Al	Ba	Bi	Be	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Sr	Ti	V	Zn
1	MCH 01	BUKURU LOWCOST STREAM	Lower	9.814027778	8.860555556	0.15	0.02	0.34	ND	0.52	0.01	0.02	ND	0.08	0.05	0.1	ND	0.04	0.02	0.15	0.03
2	MCH 02	WITT STERAM	Lower	9.8185	8.86725	0.12	0.62	0.34	ND	0.54	0.01	0.03	0.05	0.08	0.04	0.12	0.01	0.04	0.03	0.14	0.03
3	MCH 03	RAT CONFLUENCE	Lower	9.822277778	8.870805556	0.12	0.01	0.34	ND	0.52	0.01	0.02	0.01	0.03	0.04	0.13	ND	0.03	0.03	0.14	0.03
4	MCH 04	RAT HAND DUG WELL	Lower	9.822055556	8.869611111	0.15	0.04	0.32	ND	0.49	0.02	0.02	ND	0.05	0.03	0.13	ND	0.03	0.04	0.16	0.02
5	MCH 05	Pyeng STREAM	Middle	9.827333333	8.873944444	0.09	0.02	0.29	ND	0.45	0.02	0.03	0.01	0.28	0.02	0.13	ND	0.04	0.04	0.14	0.03
6	MCH 06	LAYON STREAM	Middle	9.834833333	8.868083333	0.11	0.54	0.27	ND	0.37	0.02	0.03	0.02	0.23	0.02	0.12	ND	0.06	0.05	0.15	0.05
		WHO/NSDWQ				**0.20**	**0.70**			**0.003**			**1.00**	**0.30**	**0.20**	**0.02**	**0.01**				**3.00**

The trace elements cadmium and nickel exceed the WHO recommended limits of 0.003ppm and 0.07ppm in all the samples

Irrigation and Livestock Water Quality in Pyeng Catchment

Table 5. Irrigation water quality for some selected areas

S/N	SAMPLE ID	LOCATION	COORD (N)	COORD (E)	SALINITY HAZARD	SAR	ESR	MAGNESIUM HAZARD
1	MCH 01	BUKURU LOWCOST STREAM	9.81403	8.86056	LOW	0.007	0.728	23.5
2	MCH 02	WITT STREAM	9.8185	8.86725	LOW	0.008	0.788	32.1
3	MCH 03	RAT CONFLUENCE	9.82228	8.87081	LOW	0.007	0.795	22.8
4	MCH 04	RAT HAND DUG WELL	9.82206	8.86961	LOW	0.080	0.880	23.3
5	MCH 05	Pyeng STREAM	9.82733	8.87394	LOW	0.100	1.000	24.1
6	MCH 06	LAYON STREAM	9.83483	8.86808	LOW	0.001	0.841	25.8

The salinity hazards in all the waters are low and so are Sodium Absorption Ratio, Exchangeable Sodium Ratio and Magnesium Hazard.

Soil Classification, Description and Capability

Land Capability Classification of the catchment area are follows:

- Class III: This class has the following attributes:
  - High susceptibility to water erosion
  - Low water holding capacity
  - Low soil fertility not easily corrected
- Class V to VIII: This consist of a complex of land types with the following attributes:
  - Low water holding capacity
  - Steep slopes
  - Gully erosion
  - Shallow rooting zone
  - Mining activities

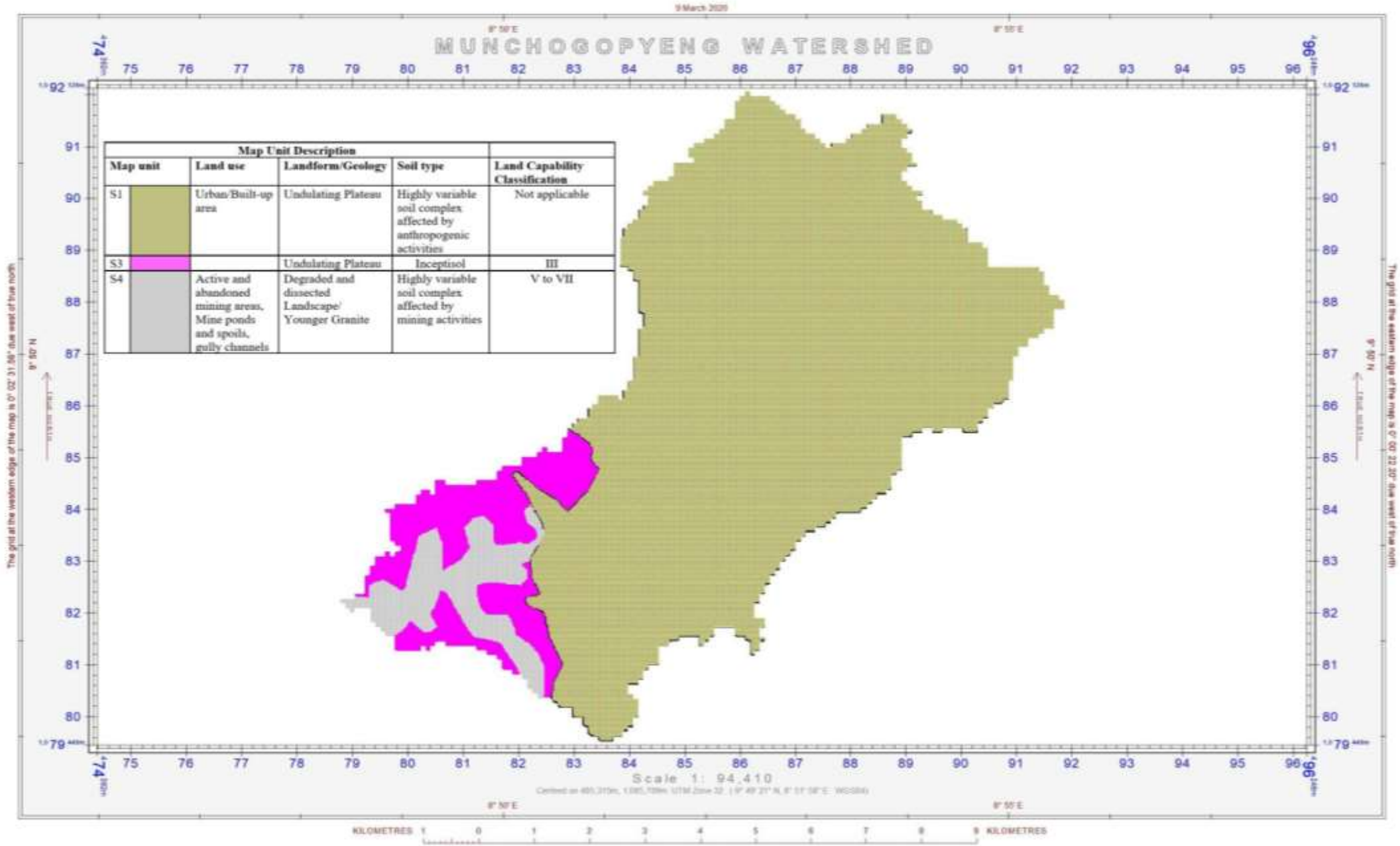


Figure 8. Soil map of Pyeng Catchment

Table 6. Soil Physical Properties

Profile	horizon	Depth (cm)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Texture	K factor	Bulk Density ($glcm^3$)	Porosity (%)
Muncho1	A	0-23	11.53	87.2	6.8	6	LS	0.75	1.98	25.28
	C	23-40	26.09	87.2	7.2	5.6	GLS	0.73	1.14	56.98
Muncho2	A	0-30	4	77	10.6	12.4	SL	1.24	0.76	71.32
	AB	30-50	25	68.6	18	13.4	GSL	1.06	0.97	63.40
	B	50-90	5.55	77.4	8.6	14	SL	1.52	1.08	59.25
	C	90-150	14.81	78.22	7.78	14	SL	1.48	1.07	59.62

Table 7.Soil Chemical Properties

Profile	horizon	Depth (cm)	pH	Nitrogen (%)	Organic matter (%)	Available Phosphorus (mg/kg)	Available Sulphur (mg/kg)
Muncho 1	A	0-23	4.38	0.094	3.23	16	3
	C	23-40	4.58	0.065	2.23	7	1.7
Muncho 2	A	0-30	4.18	0.058	1.99	9	2.3
	AB	30-50	4.68	0.032	1.12	6	1.8
	B	50-90	4.28	0.053	1.82	8	2
	C	90-150	4.7	0.022	0.74	5	0.52

Table 8. Cation Exchange Properties (cmol/kg)

Profile	horizon	Depth (cm)	Ca	Mg	Na	K	Exchangeable Acidity	Cation Exchange Capacity
Muncho1	A	0-23	0.92	0.36	0.0061	0.054	1.54	2.88
	C	23-40	1.55	0.51	0.018	0.13	1.61	3.69
Muncho2	A	0-30	0.95	0.38	0.007	0.054	1.56	2.95
	AB	30-50	1.03	0.47	0.01	0.1	1.59	3.2
	B	50-90	0.95	0.38	0.061	0.046	1.55	2.93
	C	90-150	1.53	0.5	0.018	0.12	1.61	3.78

Table 9. Soil color and consistence

			Color		Consistence			
Profile	horizon	depth	WET	DRY	AIR DRY	MOIST	STICKINESS	PLASTICITY
Muncho1	A	0-23	5YR 4/3	5YR 6/3	SLIGHTLY HARD	VERY FRIABLE	NON STICKY	NON PLASTIC
	C	23-40	7.5YR 5/4	5YR 6/4	VERY HARD	FRIABLE	SLIGHTLY STICKY	NON PLASTIC
Muncho2	A	0-30	7.5YR 4/4	5YR 6/4	SLIGHTLY HARD	FRIABLE	SLIGHTLY STICKY	PLASTIC
	AB	30-50	7.5YR 6/4	10YR 8/5	EXTREMELY HARD	FIRM	SLIGHTLY STICKY	SLIGHTLY PLASTIC
	B	50-90	7.5YR 4/4	7.5YR 5/4	HARD	FRIABLE	STICKY	PLASTIC
	C	90-150	7.5YR 5/5	10YR 8/5	VERY HARD	FRIABLE	NON STICKY	NON PLASTIC

Table 10. Physical properties of surface soil (0-15cm depth)

Sample No.	Gravel	Sand	Silt	Clay	Texture	K factor	Bulk Density	Porosity
	(%)						(g/cm^3)	(%)
49	0	77.4	17	5.6	LS	1.18	1.08	59.25
50	0	87.2	8.4	4.4	S	0.69	1.14	56.98
51	0	87.4	8.2	4.4	S	0.68	1.19	55.09

Table 11.Chemical properties of surface soil (0-15cm depth)

Sample	pH	N	OM	P	S	Ca	Mg	Na	K	EA	CEC
No.		%		mg/kg		cmol/kg					
49	4.65	0.085	2.94	12	2.6	0.95	0.38	0.61	0.049	1.55	2.94
50	4.86	0.067	2.31	10	2.3	0.92	0.36	0.052	0.041	1.54	2.87
51	4.67	0.064	2.19	11	2	0.94	0.37	0.0056	0.051	1.54	2.91

Waste Management Practices

- At the upper catchment around National Open University under the nearby bridge, a large deposit of solid waste was sighted.
- Though as was generally observed, there seem to be a near absence of indiscriminate disposal of waste in this catchment.
- It could be as a result of government's efforts in waste evacuation in the catchment.
- However, feacal waste was observed around hills and abandoned mine sites in some of the communities.

Air Quality

Table 12. Air quality of Pyeng catchment Plateau State Nigeria

Point	Longitude	Latitude	SO2	NO2	CO	CO2	NO	O3	H2S
1	E8 55.197	N9 49.488	1.00	0.06	0.00	0.00	0.00	0.00	0.00
2	E8 52.509	N9 49.616	0.40	0.10	0.00	0.00	0.00	0.00	0.00
3	E8 51.983	N9 49.468	0.80	0.05	0.00	0.00	0.00	0.00	0.00
4	E8 51.874	N9 50.237	0.40	0.07	0.00	0.00	0.00	0.00	0.00
5	E8 51.649	N9 50.143	0.40	0.08	0.00	0.00	0.00	0.00	0.00
6	E8 51.746	N9 49.572	0.50	0.09	0.00	0.00	0.00	0.00	0.00
7	E8 52.030	N9 50.028	0.70	0.07	0.00	0.00	0.00	0.00	0.00
8	E8 52.117	N9 50.273	0.10	0.07	0.00	0.00	0.00	0.00	0.00
9	E8 53.186	N9 54.188	0.70	0.05	0.00	0.00	0.00	0.00	0.00

Generally, all the parameters are below the NESREA Regulatory limits

Climate Issues

- The present climate status and future trends in the project locations were determined through analysis of the elements of climate including rainfall, temperature (minimum, maximum and mean), relative humidity and wind speed. 35 years (1979-2013) climatic data was sourced from Global Weather (2019).
- Generally, rainfall in the entire area is declining.
- Temperature is on the increase.
- The wind speed varies between 2 and 6 knots for most of the year with an average speed of about 4 knots. The maximum wind speed recorded within the period was 10 knots.

Biodiversity

Table 13. List of plants species in Pyeng Catchment

S/No.	Scientific Name	Common Name	Family	Status
1	*Moringaoleivera*	Horse raddish	Moringaceace	Common
2	*Ficusplatyphylla*	Gamji tree (fig)	Moraceace	Endangered
3	*Azadirachtaindica*	Neem	Meliaceace	Common
4	*Eucalyptus torrieriana*	River red arm/Rastata	Myrtaceace	Common
5	*Tectonagrandis*	Mints teak	Lamiaceace	Rare
6	*Annonasenegalensis*	Wild custard apple	Annanaceace	Common
7	*Eucalyptus torrieriana*	River red arm/Rastata	Myrtaceace	Common
8	*Tectonagrandis*	Mints teak	Lamiaceace	Rare
9	*Calotropisprocera*	Sodom apple/ rubber bush	Apocynaceace	Rare
10	*Calotropisprocera*	Sodom apple/ rubber bush	Apocynaceace	Rare
11	*Mangiferaindica*	Mango	Anacardiaceace	Common
12	*Parkiabiglobasa*	Locust bean	Fabaceae	Common

13	*Delonixregia*	Purple bauhinia	Fabaceae	Common
14	*Albezialebbeck*	Flea tree or fry wood	Fabaceae	Rare
15	*Jacaranda mimosofolia*	Mucakaranda	Bignoniaceace	Endangered
16	*Eucalyptus camaldulensis*	River red gum or Rastata	Myrtaceace	Common
17	*Leuceanaleucocephala*	White lead tree	Fabaceae	Rare
18	*Syzygiumguineense*	Wood land/water berry	Myrtaceace	Endangered
19	*Psidumguajava*	Guava	Myrtaceace	Common
20	*Carissa edulis*	Dog banes	Apocynaceace	Rare
21	*Sennasemeaa*	Cassod tree	Fabaceae	Common
22	*Citrus sinensis*	Sweet orange	Rutaceace	Common
23	*Jatrophacurcas*	Pig nut	Euphorbiaceace	Common
24	Terminaliaindica	Termarin	Fabaceae	Common
25	*Thevetiaperuviana*	Mexican oleander	Apocynaceace	Common
26	*Gmelinaarborea*	Beech wood/white teak	Verbanaceace	Common

Table 14. Wildlife species in Pyeng catchment

S/N	Scientific Name	Common Name	Family	Status
1	*Otter strew*	Potamogalevelox	Insectovore	Rare
2	*Epixerusepii*	African palm squirel	Rodent	Rare
3	*Gazelladorcas*	Dorcas gazelle	Artrodactyla	Endangered
4	*Python zebae*	Rock python	Reptiles	Endangered
5	*Manisgigantean*	Giant pangolin	Phoeidota	Endangered
6	*Manistricuspus*	Tree pangolin	Phoeidota	Endangered
7	*Felisaurata*	Golden cat	Carnivora	Endangered
8	*Felis caracal*	Caracal	Carnivora	Endangered
9	*Felislibyca*	Wild cat	Carnivora	Rare
10	*Cephalophussylviculto r*	Yellow backed duiker	Artrodactyla	Rare
11	*Gorilla gorilla*	Gorilla	Primate	Endangered
12	*Felisserval*	Serval	Carnivora	Endangered

Table 15. List of some bird species in Pyeng catchment

S/N	COMMON NAME	SPECIES	FAMILY	NUMBER	CONSERVATION STATUS
1	Hamerkop	*Scopus umbretta*	Scopidae	4	least concern
2	Red eyed-dove	*Streptopelia semitorquata*	Columbidae	8	least concern
3	Adamawa Turtle dove	*Streptopelia hypopyrrha*	Columbidae	10	least concern
4	Crested Lark	*Galerida cristata*	Alaudidae	5	least concern
5	Black Kite	*Milvus migrans*	Accipitridae	2	least concern
6	Yellow-Crowned gonoleck	*Laniarius barbarus*	Malaconotidae	1	least concern
7	Yellow-Fronted tinker bird	*Pogoniulus chrysoconus*	Lybiidae	1	least concern
8	Northern Red Bishop	*Euplectes franciscanus*	Ploceidae	5	least concern
9	Black billed-wood Dove	*Turtur abyssinicus*	Columbidae	6	least concern
10	Black Crowned tchagra	*Tchagra senegalus*	Malaconotidae	3	least concern
11	Red-Billed Firefinch	*Lagonosticta senegala*	Estrildidae	3	least concern
12	Village Indigobirds	*Vidua chalybeata*	Viduidae	2	least concern
13	Common Bulbul	*Pycnonotus barbatus*	Pycnonotidae	6	least concern
14	Laughing Dove	*Spilopelia senegalensis*	Columbidae	10	least concern
15	Black Kite	*Milvus migrans*	Accipitridae	1	least concern

Land Use and Land Cover Dynamics

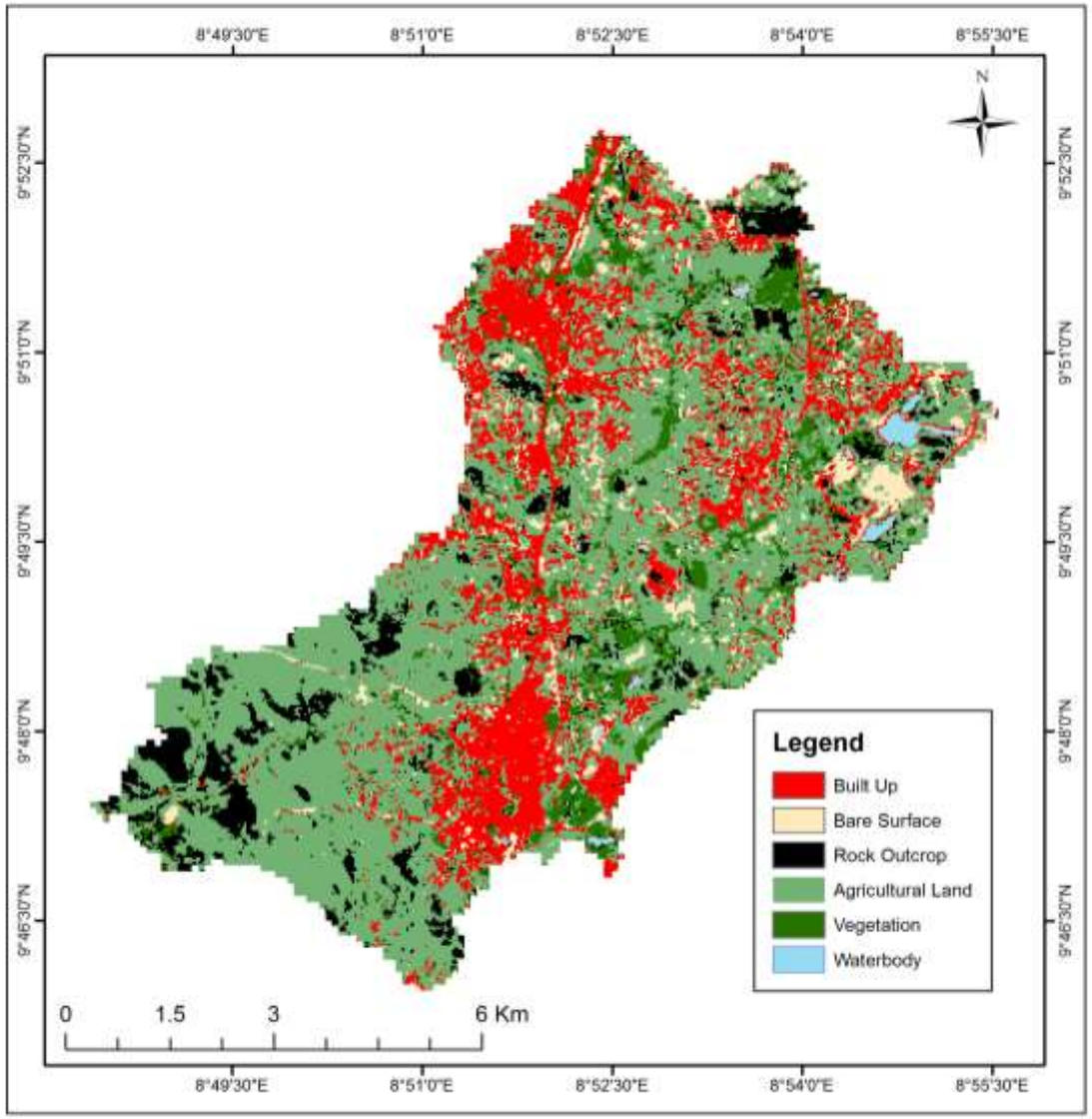


Figure 9. Land use and Land cover classes 2010

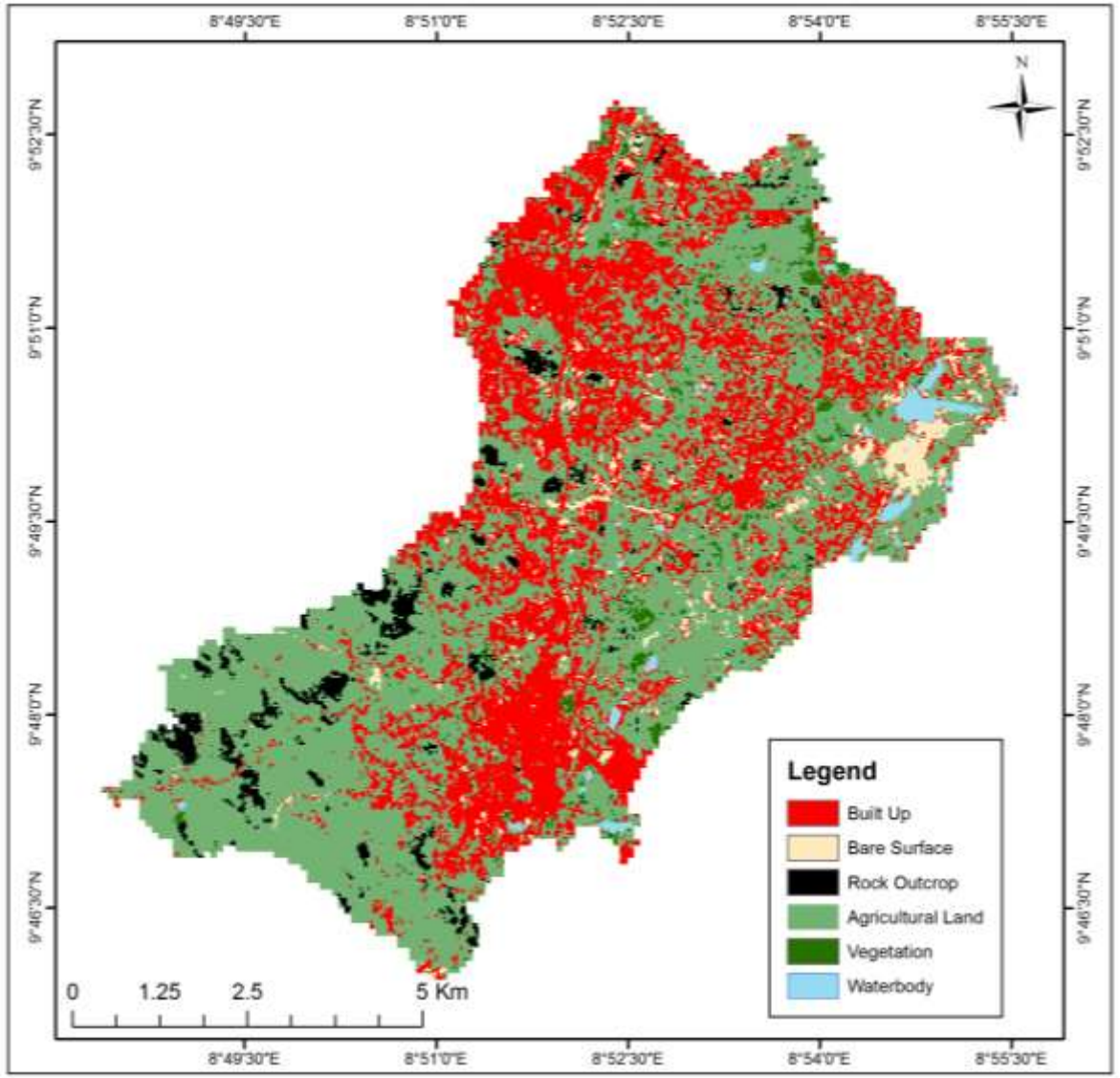


Figure 10. Land use and Land cover classes 2020

Table 16. Statistics of Land use classes in 2010

Class Name	Area (Ha)
Built Up	1380.96
Bare Surface	91.17
Rock Outcrop	488.34
Agricultural Land	549.09
Vegetation	501.12
Water Body	1.97

Table 17. Statistics of Land use classes in 2010

Class Name	Area (Ha)
Built Up	1489.77
Bare Surface	78.57
Rock Outcrop	131.76
Scattered Cultivation	1152.63
Vegetation	158.34
Waterbody	1.69

Demographic and Socio-Economic Characteristics

Table 18. Distribution based on family size

Family size	Frequency	Percent
≤3	21	22
4-9	69	72
10-15	6	6
≥16	0	0
Total	96	100

Table 19. Distribution based on age

Age	Frequency	Percent
≤25	50	53
26-45	33	35
46-65	11	12
66-85	1	1
.≥86	0	0

Table 20. Distribution based on the sources labour

Labour source	Frequency	Percent
Family	33	57.9
Hired	22	38.6
Mechanized	0	0.0
Communal	2	3.5
Family and hired	0	0.0
Family and communal	0	0.0

Table 21. Distribution based on the estimates of total and Per capita income

Variable	**Pyeng**
Number of responses	53
Total income	2813900
Per capita income	53092.453

Table 22. Estimates of the poverty status of respondents

Poverty category	**Frequency**	**Percent**
Poor	49	67
Non-poor	24	33
Total	**73**	**100**
FGT poverty indices		
Poverty incidence(P_0)	0.645	
Poverty depth (P_1)	0.446	
Poverty severity (P_2)	0.345	
Poverty line		
MPCHE	₦ 243, 861.87	
2/3*MPCHE	₦ 25, 336.30	

The Foster, Greer and Thorbeck (1984) weighted poverty index was used to determine the poverty status of the catchment areas inhabitants

Table 23. Distribution based of the livelihood activities of respondents

Livelihood options	Frequency	Percent
Farming	23	43
Salary earner	8	15
Processing of products	7	13
Craftsman/artisans	4	7
Small trade	12	22
Total	**54**	**100**

Key Findings

- The gullying observed beside the National Open University of Nigeria is as a result of stream bank erosion and back-cutting caused by the flowing water of a tributary of a major river. Some buildings were observed to be under threat from the erosion menace (Plate 2 and 3).

Plate 2. A building beside the open university at the verge of collapsing as a result of erosion

Plate 3. Buildings along a stream being threatened by erosion

Figure 11. Satellite imagery of the area around the National Open University of Nigeria
(erosion site is in red circle)

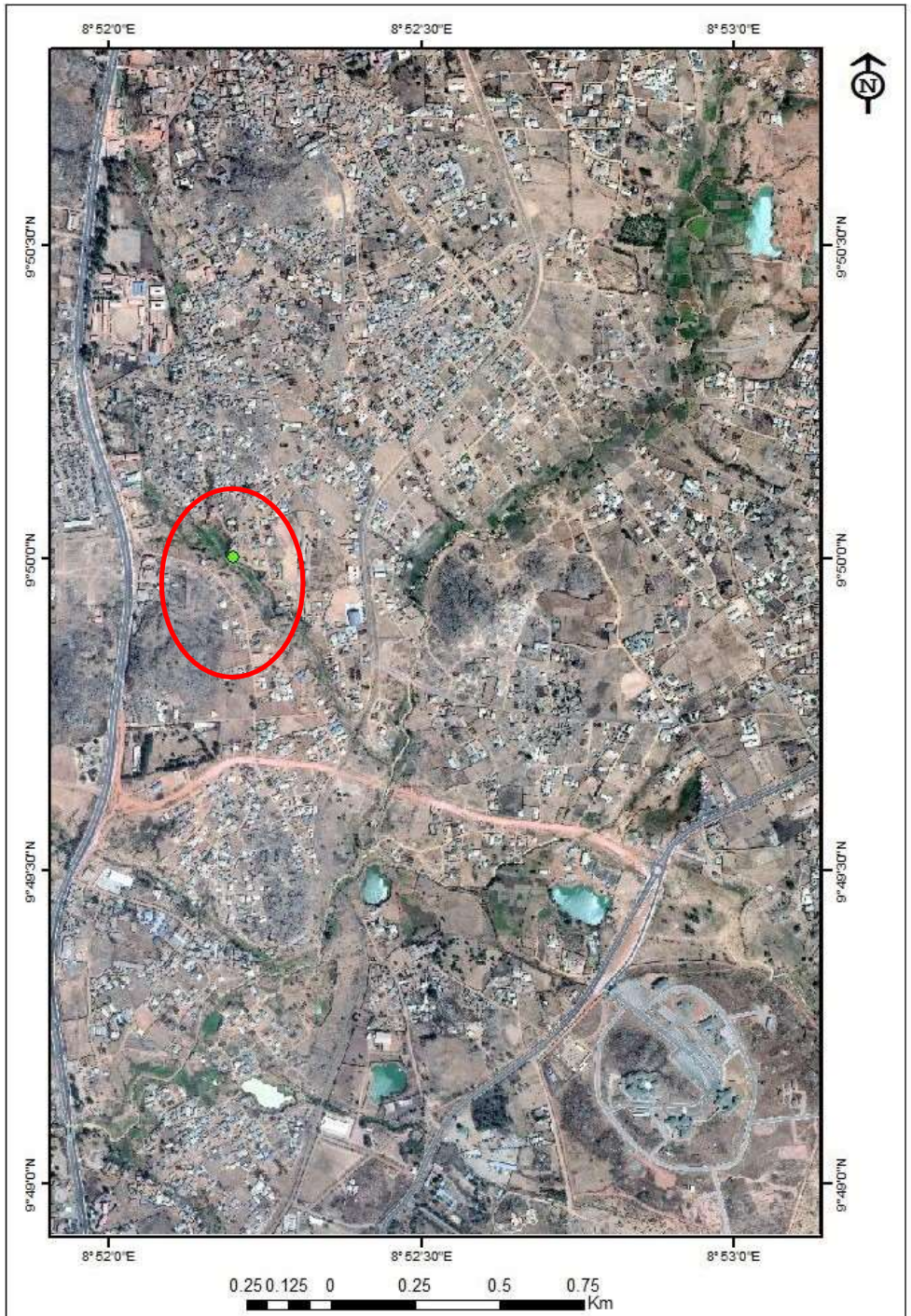


Figure 12. Satellite imagery of the area behind the former Uma bread bakery (erosion site is in red circle)

- Pyeng community satisfy their water needs for domestic purposes from pipe borne water and individual motorised boreholes and hand dug wells.
- Because of the locations of the streams, they have been used by the communities as waste dump, open defecation sites and their waters are being used for irrigation activities. Coliform counts in the waters are higher than what the WHO and the NSDWQ recommended probably due to rampant open defecation in some parts of the catchment.
- The cloudy nature of the water in the lower catchment has led to high *E.coli* concentration isolated from the waters compared to the upper and middle catchments. Also, cadmium and nickel are higher in the lower catchment than the middle; these probably may be the result of huge plastic materials and polyethene bags that have been dumped in the stream channel.

- The gaseous elements in the catchment are within the limits for urban air quality standard as given by the National Environmental Standards and Regulatory Agency (NESREA).
- The climate analysis of the catchment shows temperature is on the increase leading to higher evapotranspiration, vegetation loss with capacity to enhance soil erosion.
- Natural vegetation has been tempered with by the activities of human in the area, due to collection of fuel wood, income generation and building which has fragmented the forest ecosystem and cause run off and erosion.
- The study found that most of the households in the catchment were poor based on the poverty line. The result indicated that 67% of the households fell below the poverty line. Majority of them (88%) were within the active age bracket of less than 45 years.

S/N	KEY PROJECT ACTIVITIES	TARGET	TIMELINE	EXPECTED OUTPUT	RESPONSIBILITY	MONITORING INDICATOR
PRIMARY PRIORITY						
1	Planting of trees, shrubs and grasses on vulnerable lands	Entire community		Re-vegetation of the catchment and eventual slowing down of erosion process	Horticulture/forestry experts, community	Number of trees crops, shrubs and area of grasses planted.
2	Provision of waste bins	Whole community		Waste is properly disposed	Ministry of Environment, Community	Number of waste bins provided
3	Enlightenment campaign on best practices on solid waste management, soil and water conservation	The whole community		Improved crop yields and water quality	Contractor, Ministry of environment, community.	Enlightenment campaign on best practices for soil fertility management and soil conservation
SECONDARY PRIORITY						
1	Homestead tree planting to curb erosion and provide income to community	Whole community		Re-vegetation of the catchment and eventual slowing down of erosion process and provion of income	Horticulture/forestry experts, community	Number of trees planted
2	Provision of public toilet facilities	CIG Waste management		Reduction in open defecation	Consultant, Ministry of environment, community.	Number of toilet facilities provided
3	Regulation and organization of quarries	Stone crushers and the whole community		Enlightenment on advantages of proper mining activity	Ministries ofSolid minerals, Health, Water Resource, , Community.	Regulation and organization of artisanal mining of tins and columbites

CMP for the upper catchment

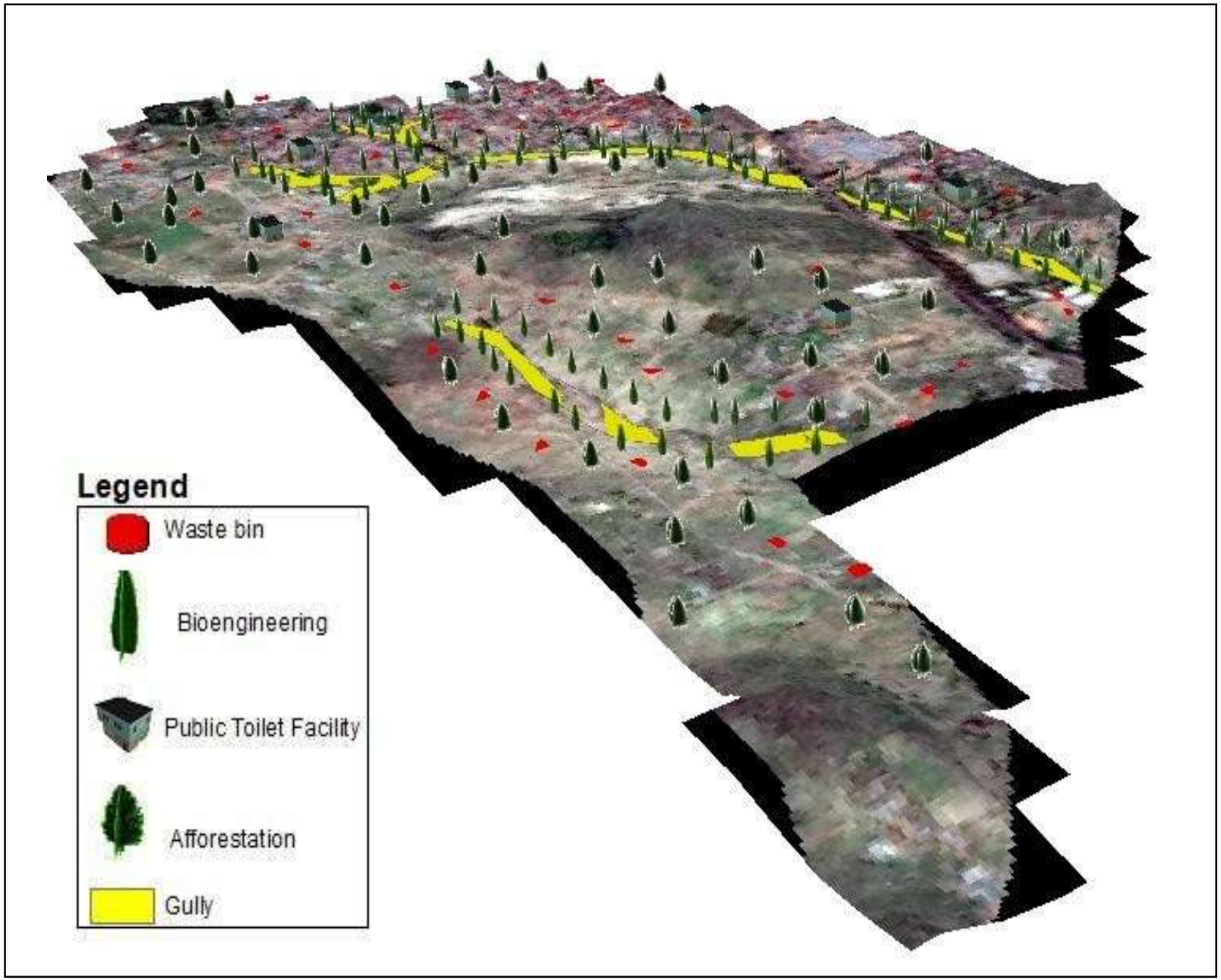


Figure 13. 3D view of the upper catchment showing the locations of some of the proposed interventions

S/N	KEY PROJECT ACTIVITIES	TARGET	TIMELINE	EXPECTED OUTPUT	RESPONSIBILITY	MONITORING INDICATOR
PRIMARY PRIORITY						
1	Planting of trees, shrubs and grasses on degraded lands	Entire community		Re-vegetation of the catchment and eventual slowing down of erosion process	Horticulture/forestry experts, community	Number of trees crops, shrubs and area of grasses planted.
2	Bioengineering interventions using some specified plant species	Planting of trees Along a stretch of about 500 meters along the gully banks		Stream bank stabilization	Contractor, Community	500 m Stretch of stream bank stabilized
3	Provision of waste bins	Whole community		Waste is properly disposed	Ministry of Environment, Community	Number of waste bins provided
4	Provision of public toilet facilities	CIG Waste management		Reduction in open defecation	Consultant, Ministry of environment, community.	Number of toilet facilities provided
5	construction of compost pit	CIG Waste management		Waste is properly disposed and manure is produced.	Community, Environmental management expert	Number of pits provided
6	Enlightenment campaign on best practices on solid waste management, soil and water conservation	The whole community		Improved crop yields and water quality	Contractor, Ministry of environment, community.	Enlightenment campaign on best practices for soil fertility management and soil conservation
SECONDARY PRIORITY						
1	Training of CIG on plant nursery establishment and practices	Focus groups and CIGs		Availability of seedlings/cutting for erosion control and homestead planting	Horticulture/forestry experts, community	Number of seedlings and cuttings propagated
2	Regulation and organization of artisanal mining of tin and columbite	Artisanal miners and the whole community		Enlightenment on advantages of proper mining activity	Ministries of Solid minerals, Health, Water Resource, community.	Regulation and organization of artisanal mining of tin and columbite

CMP for the Middle Catchment

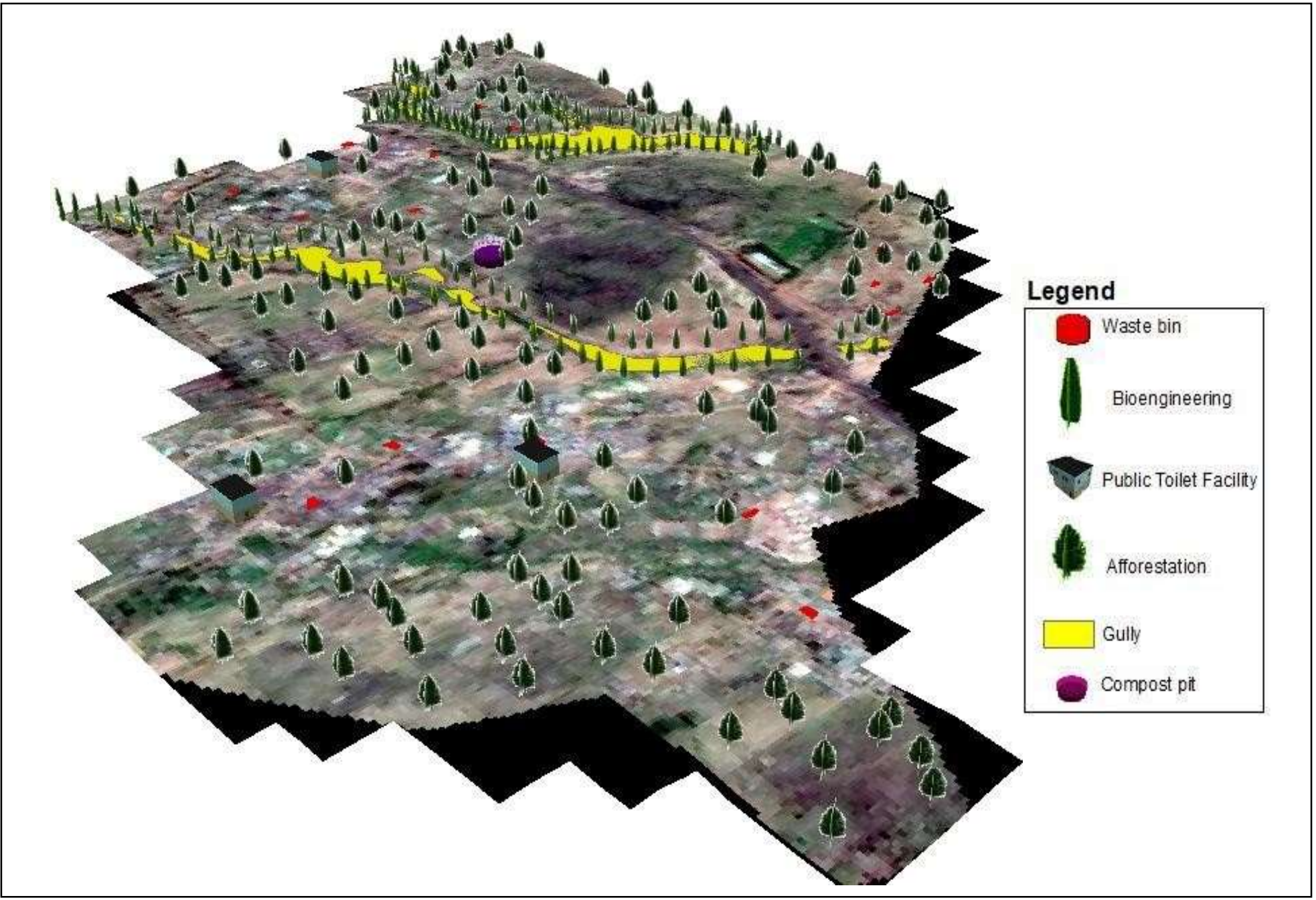


Figure 14. 3D view of the middle catchment showing the locations of some of the proposed interventions

CMP for the Lower Catchment

S/N	KEY PROJECT ACTIVITIES	TARGET	TIMELINE	EXPECTED OUTPUT	RESPONSIBILITY	MONITORING INDICATOR
PRIMARY PRIORITY						
1	Planting of trees crops, shrubs and grasses on gully banks, degraded lands, hilly slopes and terraces	2000 trees, crops and shrubs 150 sqm of grasses/turfs		Re-vegetation of the catchment and eventual slowing down of erosion process	Horticulture/forestry experts, community	Vulnerable areas covered with trees, crops and shrubs 2. 2000 trees planted
2	Bioengineering interventions using some specified plant species	Planting of trees Along a stretch of about 500 meters along the gully banks		Stream bank stabilization	Contractor, Community	500 m Stretch of stream bank stabilized
3	Provision of waste bins	The whole community		Stream bank stabilization	Contractor, Community	Stretch of stream bank stabilized
4	Provision of public toilet facilities	CIG Waste management		Reduction in open defecation	Consultant, Ministry of environment, community.	Number of toilet facilities provided
5	Training of CIG on sustainable solid waste management and the conversion of waste to wealth	CIG Waste management		Enlightenment on the dangers of consumption of water high in cadmium	Ministry of Health, Water Resources, community.	Identification of the source(s) of high cadmium concentration in water within the catchment
6	Enlightenment campaign on best practices on solid waste management, soil and water conservation	The whole community		Improved crop yields and water quality	Contractor, Ministry of environment, community.	Enlightenment campaign on best practices for soil fertility management and soil conservation
SECONDARY PRIORITY						
1	Regulation and organization of artisanal mining of tin and columbite	Artisanal miners and the whole community		Enlightenment on advantages of proper mining activity	Ministries ofSolid minerals, Health, Water Resource, community.	Regulation and organization of artisanal mining of tin and columbite

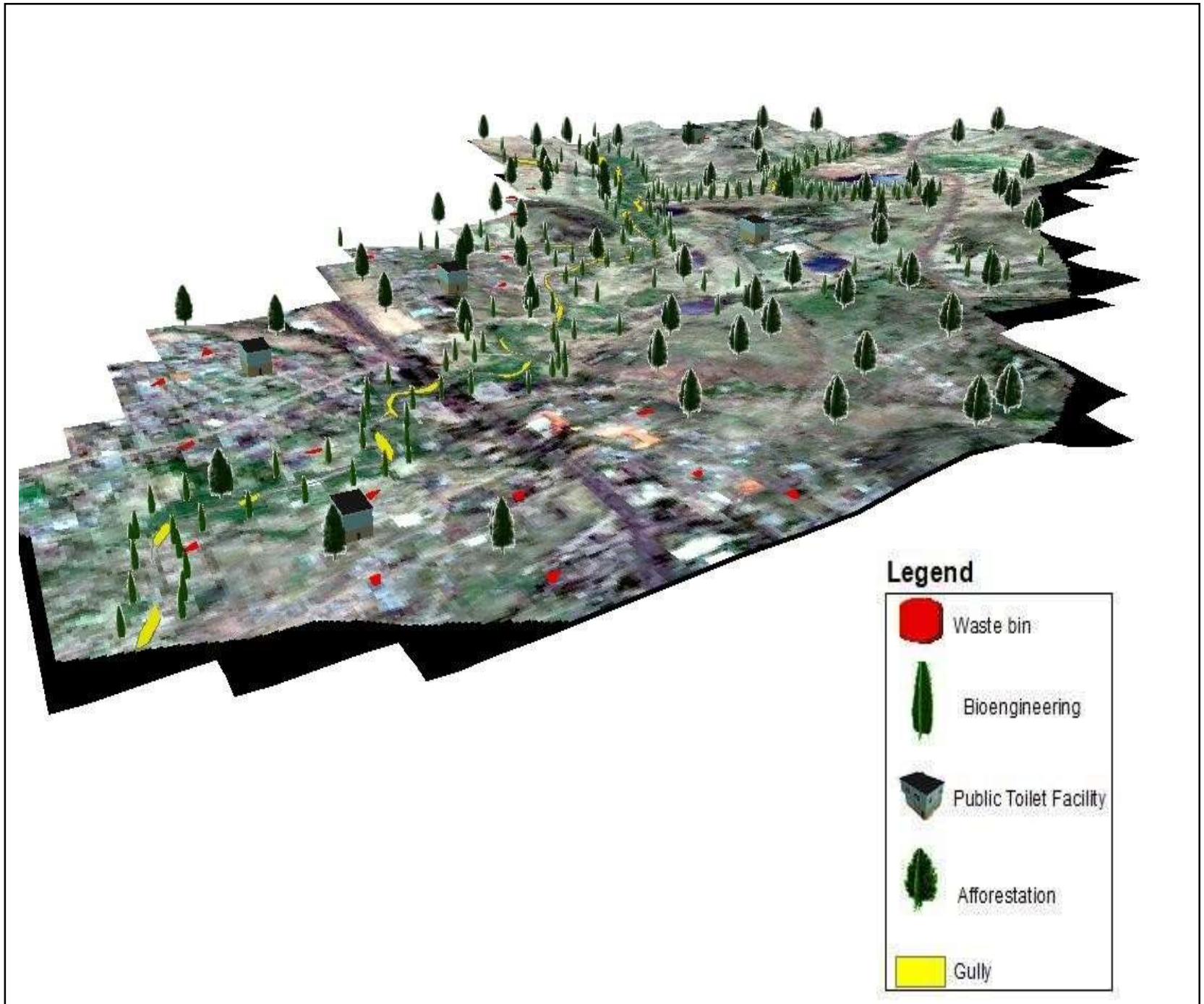


Figure 15. 3D view of the lower catchment showing the locations of some of the proposed interventions

Conclusion

- The suggested interventions combines the process of engagement and consultation into several mitigation actions to achieve desirable outcomes for the development of the catchment.
- It is expected that this sub-catchment ICMP will undergo periodic review to maintain relevance to national, regional and local policy.
- It is also recognized that monitoring of possible changes within the catchment will be required as the development advances.

References

Abu, A. (2011). Project Information Document (PID) Concept Stage: Nigeria Erosion and Watershed Management Project Report No. AB6300. A Project document submitted to the Federal Ministry of Agriculture, Abuja, Nigeria.

Giddens, A. (2008). The Politics of Climate Change: National Responses to the Challenge of Global Warming. London: Policy Network.

Igbokwe, J. I., Akinyede, J. O., Dang, B., Alaga, T., Ono, M. N., Nnodu, V. C. and Anike, L. O. (2008). Mapping and monitoring of the impact of gully erosion in Southeast Nigeria with satellite remote sensing and geographic information system, the international archives of the photogrammetry, remote sensing and spatial information sciences, vol. xxxvii, part B 8, Beijing.

Japan International Cooperation Agency (JICA) (2014). The Project For Review And Update of Nigeria National Water Resources Master Plan. Federal Ministry Of Water Resources. Volume 2.

Jimoh, H. I. (2008). Approaches to studying soil erosion problems in a tropical environment: An overview. Pakistan Journal of Social Sciences, 5(2): 142-146.

NSDWQ, (2007). Nigerian Standard for Drinking Water Quality. Nigerian Industrial Standard (NIS) 554, Standards Organization of Nigeria p30.

THANK YOU FOR YOUR TIME