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ASSESSING THE EFFECT OF FLOOD ALONG THE RIVERINE COMMUNITIES OF NUMAN AND DEMSA LOCAL GOVERNMENT AREAS OF ADAMAWA STATE AREAS

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ABSTRACT

This study exploits the integrated approach of Remote Sensing and GIS techniques in flood This study exploits the integrated approach of Remote Sensing and GIS techniques in flood management with the goal of mapping areas vulnerable to flood hazard in the study area. Since the occurrence of flood in Nigeria, the Federal Government through the National Emergency Management Authority (NEMA) is planning resettlement of the affected communities in all the states to saver places. However, the fear of the people is that the selection of the communities that are supposed to be compensated or relocated may also suffer the same problems that arose from the disbursements of funds to the flood victims shortly after the floods (Adamawa State Government, 2012). The data, on which the disbursements of the funds were based, were manually generated and analyzed. For instance, among the envisaged problems was that the names of the communities that need resettlement may disappear, while some villages that are far from being affected by the flood may be recommended for resettlements for the sake of the financial benefits. Hence, to avoid these problems, there is the need for automated means of data generation and decision making so as to bring a reliable and lasting solution to the aforementioned problems. Geographic Information System (GIS) and Remote Sensing (RS) has the capability of automatic data generation and decision making ability on spatial and non-spatial referenced features.

It was observed in the study that the floods at the valleys and downstream of River Benue were seriously devastating following the release of water from the Lagdo dam that was located at the upstream of River Benue in the Republic of Cameroon as well as heavy precipitation, areas prone to flood was determine based on the proximity of the settlement to the water body, Topographic Map and image from Nigeria sat of 2012 was respectively processed, scanned, digitized, classified and overlaid using Iliwis and other ArcGIS software's to generate classified Land use/land cover map, Digital Elevation Map and Flood vulnerability map of the study area. The results obtained shows that, areas such as Bilachi, imburu, Dwam, which are lying along the banks of the River and are on a lower altitude are most vulnerable to flood hazards, much of the area is built up and farm lands and this gives rise to high vulnerability to flash flood hazards while the vulnerability is decreasing towards the northern part of the communities where areas

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such as the Southern parts of numan, Bara, Shabari, with a higher altitude are less vulnerable to flood hazard. It is therefore recommended that Construction of a dam at the upstream of River Benue to hold back waters that are annually released at Lagdo dam Cameroon, should be revisited, remote sensing data from National Space Research and Development Agency (NASRDA) should be utilized, digital Elevation Model (DEM) of the State and the country at large should be developed and Public awareness as well as law should be given to discourage settlement and other activities such as farming within areas that are prone to flood disaster

Keywords: Flood, Vulnerability, Geographic information system and Remote Sensing

1. INTRODUCTION

Kron (2002) defines flooding as a temporary covering of land by water as a result of surface waters escaping from their normal confines or as a result of heavy precipitation. Some floods can occur suddenly and recede quickly, Others take days or even months to build and discharge. Floods are major disasters affecting many countries of the world annually, especially in most flood plain areas. Floods do not only damage properties and endanger the lives of human and animals but also produce other secondary effects like outbreak of diseases such as cholera and malaria as well. In Nigeria, though not leading in terms of claiming lives, flood affects and displaces more people than any other disaster; it also causes more damage to properties. Some of the causal factors of flood disasters in Nigeria include land inundation from heavy rainfall, climate change, and blockage of drainages with refuse, construction of buildings across drainages, inadequate drainage networks, and population increase in urban areas. These factors do not act independently and flood disasters usually occur from a combination of several of them (Adeoye et al, 2009).

In 2012, heavy rains and the release of water from Lagdo dam upstream River Benue in the Republic of Cameroon resulted into serious floods in all the states (Adamawa, Taraba, Benue, Nassarawa, Plateau and Kogi) that are located along the downstream of River Benue in Nigeria. (Konwea 2012) described the flood as the worst floods Nigeria has seen in at least half a century.

The need and means to protect the environment is of great concern to man. Floods in Adamawa state has displaced many people leaving them with no access to clean drinking water and leading to cholera outbreaks. According to the Nigeria Emergency Management Agency (NEMA), five districts, namely, Fufore, Demsa, Yola North, Yola South and Numan were flooded in August and early September, 2010 when River Lagdo burst its banks. Demsa and Fufore districts, along with nearby Maiha, were hit with cholera outbreak which left 70 people dead out of over 300 infected, (Daily Trust, 2010).

Flooding is caused by several factors and is invariably preceded by heavy rainfall. The other causes of flooding are moderate to severe winds over water, unusual high tides, tsunamis due to undersea earthquakes, breaks or failures of dams, levees, retention ponds or lakes, or other infrastructure that retains surface water. The town of Numan and Demsa as a settlement on a river bank is not an exception. It has witnessed several devastating floods, occurring almost on

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an annual basis, in its recent history, especially from 1991, due to rapid and uncontrolled urbanization of the town (Mabel, 2014). The release of waters from Ladgo dam in Cameroon into the River Benue flood plain was largely responsible for the 2012 flooding in Nigeria, of which Numan and Demsa, a confluence town of Rivers Benue in Adamawa State was adversely affected.

Aim and Objectives

The study is aimed at assessing the effects of flood along the riverine areas of Numan and Demsa Local government areas of Adamawa state. The objectives are to:

1. Use NigeriaSat2 image of 2012 to identify areas that are prone to flooding.
2. Map out areas vulnerable to flood disaster.
3. Create a land use and land cover map of the flooded area.
4. Create a digital elevation model of the area.

Statement of Problem

Since the occurrence of flood in Nigeria, the Federal Government through the National Emergency Management Authority (NEMA) is planning resettlement of the affected communities in all the states to saver places. However, the fear of the people is that the selection of the communities that are supposed to be compensated or relocated may also suffer the same problems that arose from the disbursements of funds to the flood victims shortly after the floods (Adamawa State Government, 2012). The data, on which the disbursements of the funds were based, were manually generated and analyzed. For instance, among the envisaged problems was that the names of the communities that need resettlement may disappear, while some villages that are far from being affected by the flood may be recommended for resettlements for the sake of the financial benefits. Hence, to avoid these problems, there is the need for automated means of data generation and decision making so as to bring a reliable and lasting solution to the aforementioned problems. Geographic Information System (GIS) and Remote Sensing (RS) has the capability of automatic data generation and decision making ability on spatial and non-spatial referenced features

The Study Area

Numan and Demsa local government area are located in Adamawa state, the northeastern Nigeria, and it is among the four administrative divisions of the state.

Numan is located within 9°28′N and 12°2′E.It is bordered by the Guyuk to the North, Shelleng to the Northeast, Lamurde to west, Yola south to the south and it shares a state boundary with Gombe state to the southwest while Demsa is located along Lat, it is boarded by Numan to West,Mayo Belwa to Southeast,Yola south to East,Song/Gombi to Northeast and Shelleng/Guyuk to the North.

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According to the Federal Official Gazette of Nigeria (2009) Numan occupies about 746.38 square kilometers. With a total population of about 91.549 people. While Demsa occupies about 674.23 square Kilometers with a total population of about 87.254 people.

The mean annual rainfall in this area is 140-160cm annually. Rainfall is at its peak in the months of August and October while it is low in the months of July .The mean annual Temperature is 18°C -27°C.

This area occupies the northern guinea savanna vegetation of Adamawa State and are characterized by the same plants such as Afzelia Africana, Paradoxa, laxiflora, wood species with pennisetum and klyparrhrnia as the grass under growth (Usman, 2002). The soil type in this areas are combination of Eutric pelluster (USDA) pellic Vertisol(FAO).

There are three major geological zones corresponding to three structural types which in turn correspond to three associated rock types in the study area namely, the Basement complex rocks, the oldest known rock-types and are areas of uplift which consist of igneous and metamorphic rocks other than volcanic; sedimentary rocks, corresponding to areas of sedimentation, that is, the Benue trough lying wholly within the Basement complex rocks; and volcanic rocks which are isolated volcanic areas along the Benue trough and the Cameroun Volcanic line to the east and north-eastern parts of the State.

According to Adebayo and Umar (1999), the drainage of Adamawa State is dominated by three main drainage systems-the Benue, the Yedzaram and the Taraba. River Gongola also transports a large amount of sediment which accumulates at the river mouth near Numan.(FMWR, 1994). Adamawa State is in the Upper Benue catchment.

2.MATERIALS AND METHODS

In this section a detailed description of the method of identifying the areas vulnerable to flood, mapping out the area, creating a landuse landcover map of the area and observing the cause of flood in the study area. The study has utilized medium resolution imagery and a Digital Elevation Model was developed with ArcGIS to identify flood prone areas along the Numan River. The DEM was reclassified into high risk, moderate risk and low risk zones using equal interval of 1km each for the buffer separation based on distance. Then the vulnerability map of the area was produced.

Method

(a) The point data was collected by a Garmin GPS, the Canon digital Camera, Printed Copies of Satellite imageries and Base Maps were used as the field tools to identify inundated areas. Database was collected and this was done to validate the flood extent obtained from the Satellite imagery of the Study Area.

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(b) Rivers and settlements were extracted from NigerianSat 2 imagery using georefenceing and digitizing procedure. A Land use land cover map of the study area was also generated using the same image, points generated from Global Positioning Satellites (GPS) was tied to the image for verification of location. Satellite Radar Topographic Mission (SRTM) data, Topographic maps was used to obtain the digital elevation model of the study area. Image Processing was carried out using the Earth Resource Data Analysis Software (ERDAS) 9.2 .The Arc GIS 10.1 was used to perform the Supervised Classification of the Study Area to determine the Land Use and Land Cover of the terrain before the flood.

(c) The Arc hydro tools; an extension of the Environmental Systems Research Institute (ESRI) was used to preprocess the Digital Elevation Image of the Study Area by producing the agreed Digital Elevation Model (DEM) and other Operation as Sink and Flow Accumulation. Data Projection and Georeferencing. Images preprocessed in other software's were imported in the Arc GIS 10.1 software where the area of interest was extracted via the clipping process in the Arc tool box.

(d) Spatial Analysis Techniques. The analysis of the inundated areas was conducted via query by location i.e. Proximity Analysis. This was done by selecting some of river channels, and shape files of the settlement to determine areas that were adversely affected by floods. The Buffering was categorized into various ranges along the basin at distances of 1km, 2km and 3km - to represent the highly vulnerable, moderately vulnerable and safe-zone regions of the Study Area. This operation was carried out in ArcGIS software by loading all features layer (Point, Line and polygon) that cover the flood Inundated region to determine the actual spatial coverage and extent of the flood. The zoning of flood vulnerable areas was categorized into three zones (highly vulnerable, moderately vulnerable and safe-zone regions). This zoning was based on the proximity of communities along the River as well the elevation of the terrain of the study area which was taken into consideration.

3.RESULTS AND DISCUSSION

In figure 4.2 areas prone to flood was determine based on the proximity of the settlement to the water body, Generally, the natural behavior of water (flowing water) is that it moves from higher ground to lower ground. This means if there is a higher ground adjacent to a lower ground, the lower ground is a lot more likely to experience floods. the study areas is on a low-lying elevation, it has poorly drained soil, the settlements are situated at the confluence of the river, and because of the wide spread of its flood Palin ,buildings, farms and other activities springing up in many places where they have not been authorized. Some of these are placed in waterways. The danger is that, with the rains or Lagdo dam bursting its bank open, water will find its own level if it cannot find its way.

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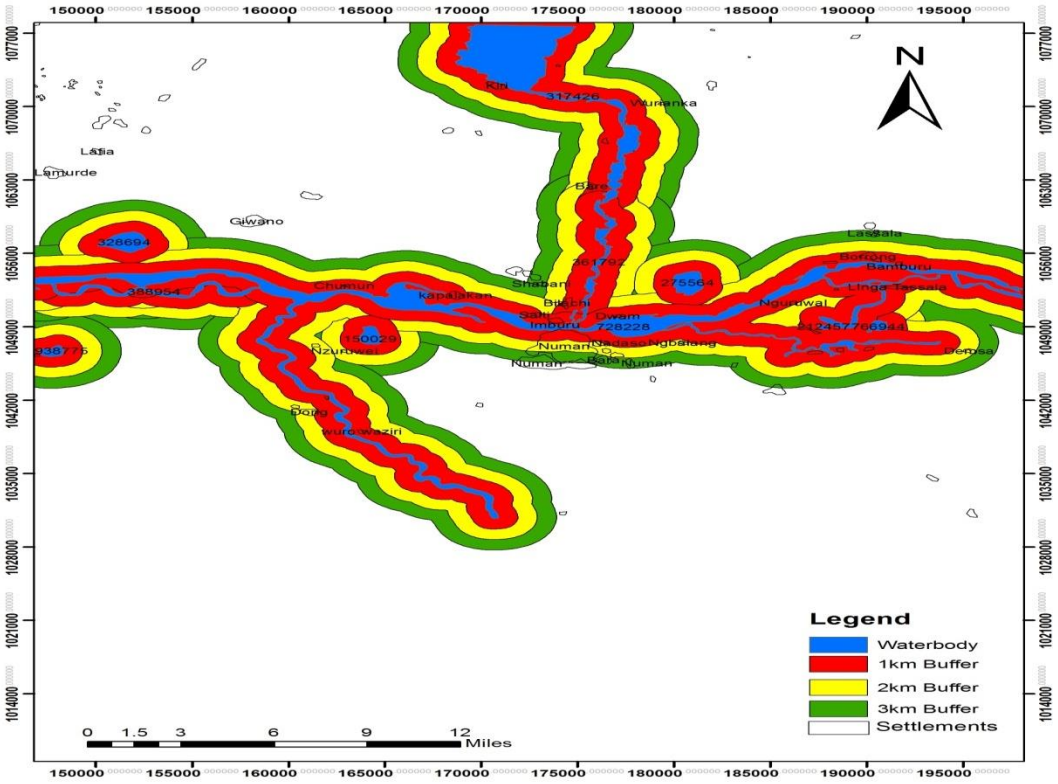

Figure 1: Vulnerability Map of the study Area, Source: Generated by Authors

Table 4: 1 Buffer Distance and Number of Submerged Houses

Buffer Distance	Number of Submerged Households	% of the Total
1km	27	29.4
2km	29	31.5
3km	36	39.1
Total	92	100

Source NCRS,2014

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Areas vulnerable to flooding

Figure 4.3 indicates the extent of flood vulnerability in this study; this was determined by the buffer created. The multiply buffer was created to determine areas that are vulnerable in terms of flood disaster. Three hazardous zones was created base on areas of High vulnerability, moderate vulnerability and areas of low vulnerability, however the topography of this area is unevenly distributed, some are of high altitude, moderate and some are of low altitude thereby making areas of low altitude vulnerable to flood disaster. Figure 4.4, 4.5 and 4.6 shows a multiple ring buffer of the river in the following criteria 1km, 2km and 3km respectively. This was performed to determine flood vulnerability extent in accordance with Space Standards for Urban Development and areas liable to flood along the river channel in the Study Area.

Landuse And Landcover (Lulc) Classification

Table 4.2 shows the various areas of land occupied by each feature class LULC map of the study area was generated through supervised classification of Nigeria Sat-X image. Erdas imagine 9.2 software was used for this analysis. Training samples set were acquired from the image to run the supervised classification of six classes (Vegetation, shrub land, farmlands, settlements, water body and bare surface) using maximum likelihood method. The total land use and land cover areas covered in the 2012 flood was extracted from the attributes and exported to Microsoft excel for analysis. The area of each class extracted was converted from meters square to hectares and bar charts were generated to illustrate graphically, the LULC areas affected in the 2012 flood disaster.

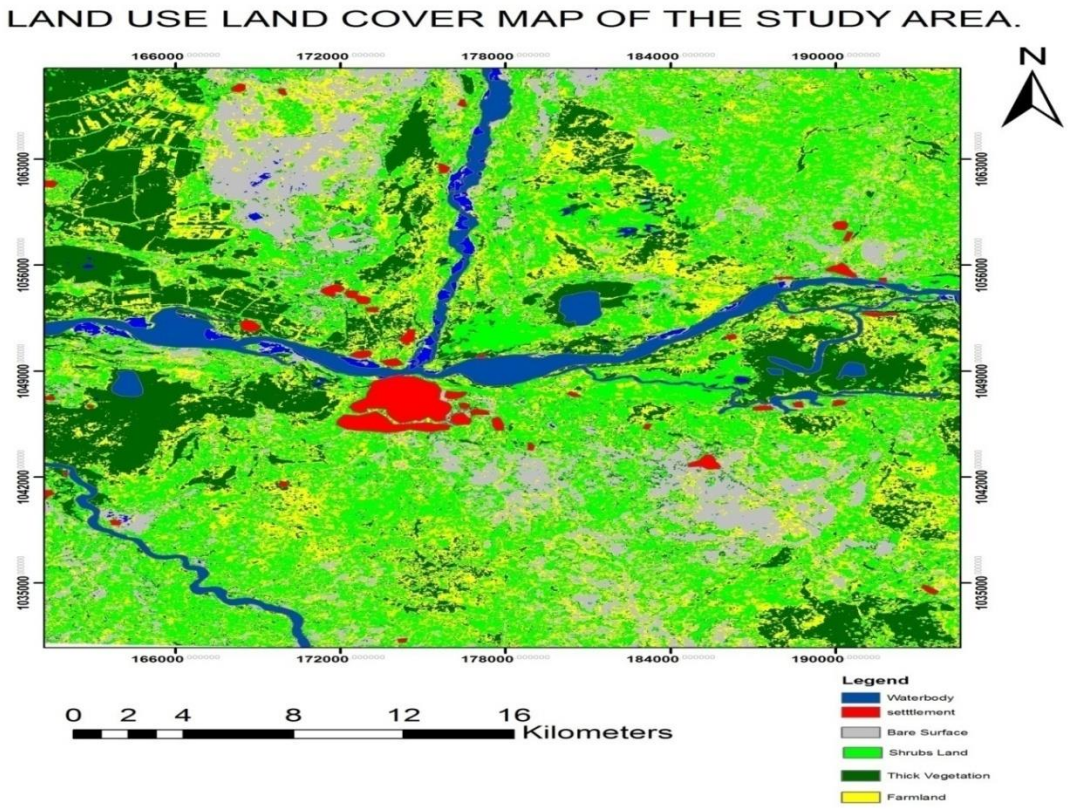

Figure 4.5: Land use Land Cover Map of the Study Area.Source; generated by Author

Table 4.2: Land use/Land cover of the study area

Land cover	Area(sqm)	Percentage %	Area(Hc)
Water body	233706.00000	3.235341593	323.5341593
Farmlands	2021952.00000	27.9911744	2799.11744
Thick vegetations	1446991.00000	20.03162164	2003.162164
Shrub Land	2511884.00000	34.77361635	3477.361635
Bare surface	989951.00000	13.70452468	1370.452468
Settlements	19050.00000	0.263721331	26.37213309

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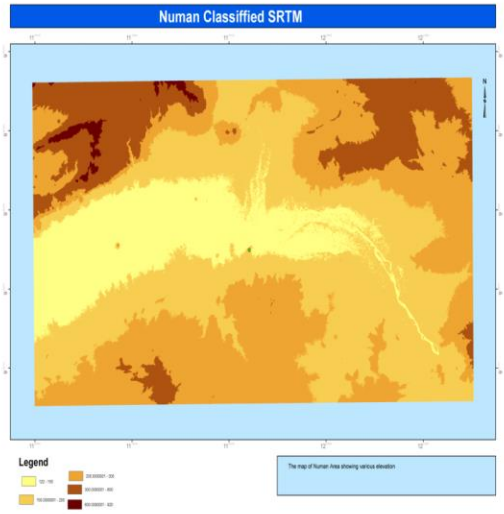
Total	7223534.00000	100	10,000.

Source ; Generated by author

Digital Elevation Model

Figure 4.7 shows the various elevation of the study area. The SRTM and topographic map was used to generate the contour lines to determine the elevation of the study area, showing areas of high altitude moderate and areas of low altitude. The elevation data obtained from the field was used to ascertain the highest point area. Figure 4.3 shows areas mapped as Vulnerable to Flood Hazard are to a large extent dominated by Settlements, Farmlands, Vegetation and this is because of the topography of the area, and the area is on the lower altitude that is less than 250m above sea level. Settlements such as Numan town, Dwam, Imburu, Bilachi, Nglang with elevation less than 250m above sea level are mapped vulnerable to flood hazard. The vulnerability of these areas to flood hazard is very disastrous. This is because of their proximity to the River. The areas above the highest elevations obtain from the field were the areas that are not flooded but the elevations below the highest point were flooded. In figure 4.10 indicates the topographic elevation of the study area in 3D shows that areas highly vulnerable to flood hazard falls between elevations ranging from 122m to 150.00m above sea level while areas falling between 150.00m to 200.00m above sea level as less vulnerable to flood hazard. The areas that fall on elevation ranging from 350.00m to 800.00m above sea level are less vulnerable to flood disaster. These shows that the areas that are highly at risk to flood are actually those lying at lower elevation.

Figure 4.6 Various Elevation of the Study Area. Source .Generated by Authors



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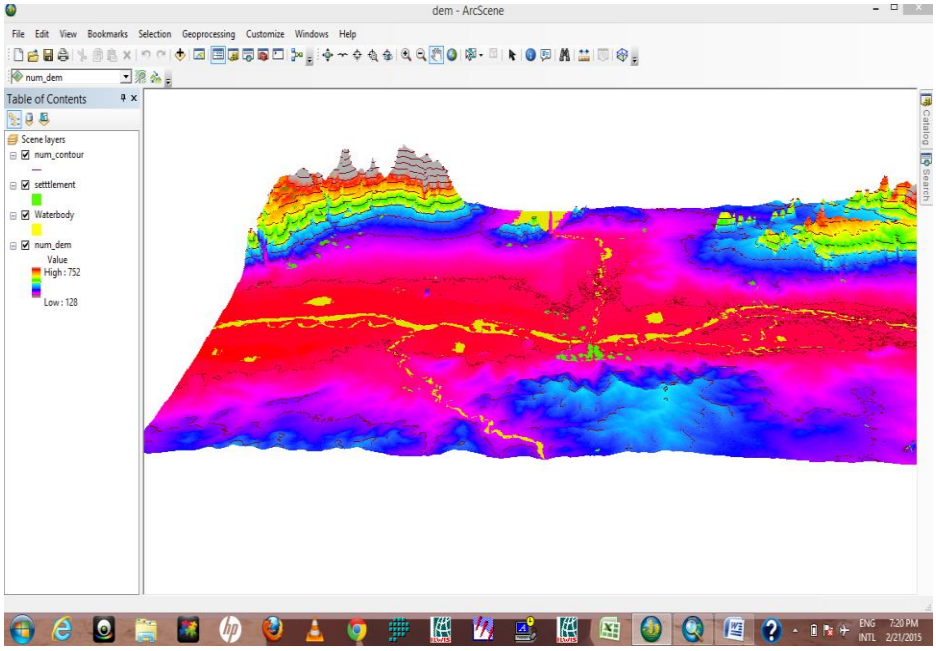

Figure: 4.7 Topographic Elevation of the Study area in 3D Source : Generated by Authors

4. CONCLUSION

This study was hence initiated with the central aim of making the use of RS and GIS techniques in mapping out areas that are vulnerable to flooding within Numan area. To address this, a methodology was developed involving, pre-processing and classification of Nigeriasat2 (2012) of the study area to show landuse/land cover information, digitizing of topographic maps of the area, generation of digital terrain model (DTM) of the area from the produced contour data, integration of the imagery data with the contour data and DTM to generate maps showing areas of different vulnerability to flood hazards within the town. Areas lying along the banks of River Numan are at locations that are most vulnerable to flood hazards with vulnerability of the town to flood decreasing towards the northern part. Much of the area is built up and this gives rise to high vulnerability to flood hazards.

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