ENVIRONMENTAL MANAGEMENT FRAMEWORK FOR THE UMGUNGUNDLOVU DISTRICT MUNICIPALITY: Flood Risk Specialist Report

Institute of Natural Resources

ENVIRONMENTAL MANAGEMENT FRAMEWORK FOR THE UMGUNGUNDLOVU DISTRICT MUNICIPALITY

FLOOD ZONE SPECIALIST REPORT

Prepared For

uMGUNGUNDLOVU
UMASIPALA WESIFUNDA
DISTRICT MUNICIPALITY
DISTRIK MUNISIPALITEIT

Prepared by

Institute of
Natural Resources
P.O. Box 100396, Scottsville, 3209
67 St Patricks Road, Scottsville, 3201
Tel: 033 346 0796
Fax: 033346 0895
e-mail: info@inr.org.za

JULY 2017

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Areas at risk of flooding are incorporated into the EMF to provide guidance for developers and planners with respect to the environmental risks associated with a particular area. Flood risk is in some ways very different to the other environmental layers included in the EMF in that the direction of the risk is inverted and it is the environment which poses the risk to the development. The flood areas do however play an important role in flood mitigation as energy is dissipated as water floods into these areas, particularly if the vegetation and topography provide a rough surface over which the flood waters must travel. These areas should therefore be protected. Areas at risk of flooding pose a high level of constraint to development both in terms of risk to the development and in terms of the functional ecological role these areas play and thus these areas should be identified and included in the ECF. This specialist report outlines the method used to identify these areas.

2. APPROACH TO THE IDENTIFICATION OF FLOOD AREAS FOR THE EMF

Flood area sensitivity assessment

Definition of sensitivity

Areas covered by the 1 in 100 year return interval flood level have been identified as flood-sensitive areas. These areas represent the flood levels which are realised by floods at the return period specified. This is a statistical calculation and it does not ensure that the 1 in 100 year flood will not occur twice in two years. This is an important consideration given the impact of climate change and the projected increase in frequency of severe storms.

The areas within these flood areas also have an important role to play in mitigating flood impacts downstream. The higher the surface roughness of these areas, the more energy is taken out of water flooding over this area, which in turn reduces the impact of flooding downstream. Developments in this zone can serve to reduce the natural surface roughness, reducing the flood attenuation service level provided to vulnerable areas downstream.

Approach to mapping flood-sensitive areas

Originally proposed approach

The following flood risk area mapping method was included in the original EMF proposal:
The mapping of flood risk areas will be undertaken using a raster based GIS elevation buffer approach which will include the following steps:

1. Identify and delineate the major river channels using a flow accumulation model
2. Estimate the relative potential magnitude of the flow based on catchment size.
3. Assign an elevation to the river channels based on a digital elevation model.
4. Buffer the stream grid by elevation to 3 classes of river rise
5. Assign terrestrial elevation cells to stream cells using a Euclidean allocation on a digital elevation model
6. Identifying all areas falling within different flood level categories
7. Weighting areas of the catchment according to gradient.
8. Assigning a risk category to terrestrial areas

Thus a layer will be generated identifying areas at varying degrees of risk from flooding.
Riparian areas will be mapped using a combination of the above process and vegetation mapping as undertaken as part of the land cover mapping process.

This approach has some limitations which were outlined at the first project steering committee meeting. Primarily, these centre on the fact that the method is based on topography and does not include a hydrological or hydraulic component. The Project Steering Committee expressed concern over the limitations and requested that other approaches be investigated, particularly for the KFAs where greater accuracy is sought.

Costing of in-field flood mapping exercise

The project team undertook a rough costing of undertaking a hydrologically and hydraulically based flood mapping exercise focusing on specific sites. The following steps were proposed:

- Obtain a sub-metre DTM covering the identified focus areas. This will require LiDAR data to be obtained as this is the most efficient/cost-effective way to cover many/large areas. The LiDAR could cost in the region of R250 000.00 for all sites.
- In absence of a high resolution DTM, conduct in-field surveys. This will require engineers to map out river cross-sections to define the channel profile. This is the most efficient/cost-effective way to cover few/small areas.
- Run a hydrological model to derive return period design flood (e.g. 1: 50 or 1:100 year flood) and run 2D HECRAS using the DTM or 1D HECRAS using the cross-sections. 2D HECRAS is more powerful and efficient than 1D as the latter requires more time for a professional to process the cross-section information and import into HECRAS. . The flood modelling and HECRAS would be in the region of R50k to R75k per site
- Map out the HECRAS results to show flood risk areas.

Overall, the proposed flood determination/mapping would require a large budget given the extent of areas. Assuming 10 sites each covering 100 ha, this would likely cost up to R1 million. On this basis it was determined that it was not a feasible option for the EMF process.

Flood Risk Information System

The PSC also recommended that the project team investigate a product produced by JG Africa for the Department of Human Settlements. The team subsequently sourced the documentation and data for this tool from the Department of Human Settlements and assessed it for applicability in the EMF process.

The Flood Risk Information System (FRIS) is a GIS based system which uses existing hydrological and flow information from a number of sites across the province to generate design flood values for these areas using the JPV method, with Veld Zone regionalisation and using the General Extreme Value (GEV) probability distribution, as developed by Görgens (2007). These values were then extrapolated to other catchments based on catchment characteristics. This approach has provided a high level flood risk assessment tool which although is limited by the resolution of available terrain models, is founded on hydrological and hydraulic modelling. This approach was presented to the PSC as the most efficient method for obtaining a flood risk layer for the District. This was accepted by the PSC and a FRIS output layer was generated for the study area.

3. IDENTIFIED FLOOD SENSITIVITY ZONES

Flood risk sensitivity zones were determined based on the FRIS 1:100yr flood risk area. These areas are all potentially at risk of flooding and thus are classified as highly sensitive. Although the riparian environment is very sensitive to disturbance, the risk from flooding lies mainly with the development and vulnerable areas downstream. The flood zones identified by the FRIS product are illustrated in Figure 1 and presented in Table 1.

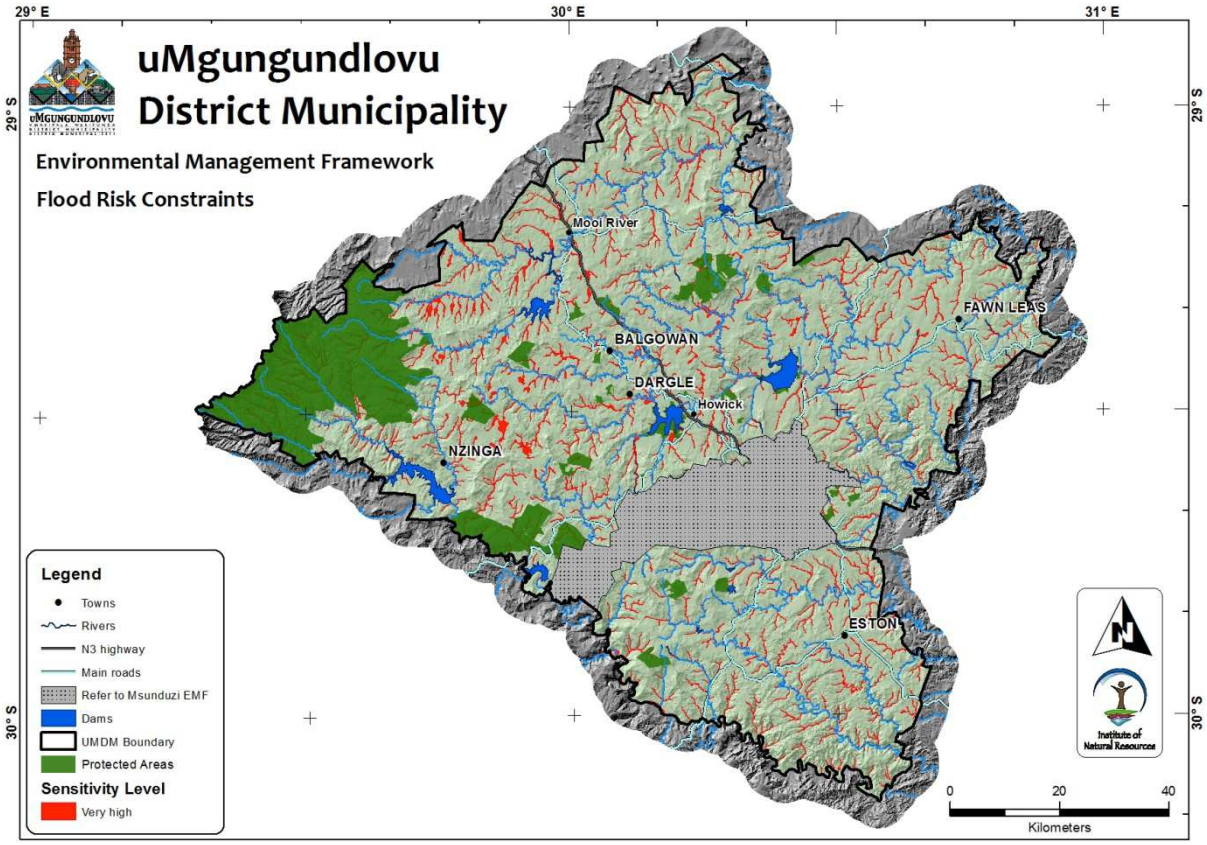

Figure 1: Flood sensitivity areas identified for the District.

Table 1: Flood zone sensitivity zones

Sensitivity Level	Flood zone
Very High	1:100 yr. flood risk area
Low	Areas outside of the modelled 1:100 year flood risk area

4. DEVELOPMENT OBJECTIVES AND EIA GUIDELINES

The Sensitivity of the identified flood risk zone is shown in Table 2 together with the objectives for managing development in these areas and guidelines for any EIA for development of these areas.

Table 2: Flood zone development objectives and EIA guidelines

Sensitivity level	Flood zone	Development objectives	EIA guidelines
Very High	1:100 year flood risk area's risk area	Any development situated within the 1:100 year flood risk zone is in **danger** of being affected by a river or stream in flood and may place people and infrastructure on-site, and upstream or downstream of the site, in danger. Developments within flood risk areas may also negatively impact upon riverine ecology and hydrology. Should development be proposed below the established flood lines (see EIA guidelines), precautions must be taken to ensure the protection of the infrastructure and people associated with that development; and, the protection of infrastructure and people both up and down-stream of the site. Buildings and residential structures should not be permitted below the 1:50 year flood line. Activities that will result in unacceptable flood risk; or, that would negatively impact on the ecological and hydrological functioning of the floodplain are not supported in the flood risk area. Flood zone areas can contain ecological features that help mitigate flooding potential and provide ecosystem services. If development cannot be avoided within a predicted flood risk area, care must be taken to ensure that the functioning of the flood	A flood line assessment should be undertaken for any application for development in these areas to accurately delineate the 1:20, 1:50 and 1:100 year flood lines. A flood risk assessment should be conducted for those proposed developments that may be impacted on by flood events, or may impact or influence flood events. A riparian and aquatic ecology impact assessment should also be undertaken for any development activities proposed to be located within the 1:100 year flood risk area. This assessment should include an assessment of the impact of any development on the riparian area, aquatic ecology of the stream, and flood attenuation service provided to downstream areas by the riparian vegetation that exists within these zones.

Sensitivity level	Flood zone	Development objectives	EIA guidelines
		zone area is not compromised. Where residual impacts remain after mitigation, the establishment of suitable off-site offsets for these residual impacts must be considered and implemented.	
Low	Areas outside of the predicted 1:100 year flood risk area	The area is not expected to experience flooding. However development anywhere in the catchment may alter the flow of water into a catchment system. It is therefore important that no development occurs that will significantly affect the flood regime of the catchment. Smaller catchments are more sensitive to flood regime changes. Activities that will result in increased hardened surfaces should be subject to storm water management. Storm water management plans should allow for the management of storm water entering the natural drainage system, ensuring that there are no cumulative effects on the catchment flow pattern. All developments within this zone should be flood neutral.	Should a drainage line or small stream occur in the vicinity of any proposed development, a flood risk assessment should be undertaken.

5. CLASSIFICATION OF FLOOD ZONE COMPATABILITY WITH LAND USE ACTIVITIES

For the purposes of mapping land use / environmental sensitivity compatibility, the constraint posed by flooding was assessed against the list of land use types developed for this EMF. A Score of 4 represents high constraint / incompatibility, while a score of 1 indicates low constraint and relative compatibility. Most infrastructural development is considered incompatible with a flood risk area. These scores are shown in Table 3.

Table 3: Impact scores of the listed land use activites on the flood zones

Land use	1:100 Yr. flood risk area
Extensive Crop Production	2
Intensive Crop Production	3
Agri-Industry	3
Intensive Animal Production	4
Extensive Animal Production	1
Forestry	3
Civic and Social	3
Cemetery	4
Intense Mixed Use	4
Medium Mixed Use	4
Residential Only Detached	4
Residential Medium Density	4
Smallholdings	3
Small Tourism	3
Medium Tourism	3
Large Tourism	4
Airport	3
Railways and Roads	3
Transport Focus Points	3
Solid Waste Site	4
Waste Water Treatment	4
Bulk Linear Infrastructure	3
Environmental Services / Conservation	1
Active Open Space	1
Passive Open Space	1
Nature Reserve	1
Dam	1
Nature and Culture Based Tourism	3
Extractive Industry / Quarrying / Mining	2
Noxious Industry	4
Logistics Hub	4
Light Industry	3